National Park Service
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Natural Resource Program Center

Data Management Plan

Klamath Inventory and Monitoring Network

Natural Resource Report NPS/KLMN/NRR—2007/012

ON THE COVER
Collage of photographs in the Klamath Network including Landbird Database (top left), Image Database (top right), Intertidal Protocol (bottom left) by Sean Mohren, botany field crew (bottom center) by Daniel Sarr, and park resources (bottom right) by Laura Bridy

Data Management Plan

Klamath Inventory and Monitoring Network

Natural Resource Report NPS/KLMN/NRR—2007/012

Sean R. Mohren
National Park Service
Klamath Inventory and Monitoring Network
1250 Siskiyou Boulevard
Ashland, OR 97520

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Table of Contents

FIGURES VI

TABLES VII

APPENDIXES VIII

EXECUTIVE SUMMARY IX

ACKNOWLEDGEMENTS XI

INTRODUCTION 1

The Inventory and Monitoring Program 1

The Klamath Network 2

Scope and Objective of the Data Management Plan 5

Types of Data Covered by this Plan 7

Sources of Data 7

Audience 9

Plan Revisions 9

ROLES AND RESPONSIBILITIES 11

Personnel Responsibilities 11

Data Management Coordination 18

INFRASTRUCTURE AND SYSTEMS ARCHITECTURE 21

Infrastructure 21

System Architecture 22

Relational Database Structure 25

Master Data Library 28

Internet Servers 28

IT Network Security 28

DATA MANAGEMENT PROCESS AND WORKFLOW 29

The Data Lifecycle 29

DATA ACQUISITION AND PROCESSING 35

Programmatic Data 35

Non-Programmatic NPS Data 41

Non-Programmatic External Data 43
Data Processing 43
QUALITY ASSURANCES AND QUALITY CONTROL 45
Data Quality and the National Park Service 45
Goals and Objectives for Quality Assurances 46
Methods for Reducing Errors in a Project 47
Data Verification 48
Data Validation 48
Data Quality Review 49
Version Control 50
DATA DOCUMENTATION 51
Mandates for Documentation 51
Roles and Responsibilities 52
Documentation Process 53
Metadata Development 57
Non-Programmatic Data Documentation 60
Derived Data Documentation 60
DATA ANALYSIS AND REPORTING 61
Data Analysis 61
GIS Product Development 62
Data Validation 62
Reports 63
Report Format 65
DATA DISSEMINATION 67
Ownership 67
Distribution and Mechanisms 67
Sensitive Data and the Freedom of Information Act 70
Feedback 72
DATA MAINTENANCE, STORAGE, AND ARCHIVING 73
Digital Data Maintenance 73
Physical Data 75

Backup Processes 76
Archiving and Storage 77
Data and Network Security 77
REFERENCES 79

Figures

Figure 1. The National Park units within the Klamath Inventory and Monitoring Network located in southern Oregon and northern California. 3

Figure 2. The personnel and supervisory structure for the Klamath Inventory and Monitoring Network..... 5

Figure 3. Breakdown of the roles, duties, and combined responsibilities of the core data management team members. 16

Figure 4. A diagrammatic of the infrastructure that the KLMN relies on for our data management processes. 22

Figure 5. An example of the Level 1 folder structure for the network shared drive..... 24

Figure 6. An example of the general file structure the KLMN will use to store and maintain inventory and monitoring project data. 25

Figure 7. System overview of the KLMN natural resource database. 28

Figure 8. Conceptual model of the cyclic process associated with the data lifecycle of a project. 30

Figure 9. Metadata documentation throughout the various phases of the data lifecycle. 54

Figure 10. Process to create, store, and distribute metadata at the national level. 56

Figure 11. Simplified conceptual model of the Natural Resource Challenge vital signs water quality data flow from collection to distribution. 69

Tables

Table 1. The National Park Service units in the Klamath Network and their size, elevations above sea level, and subregional location. 2

Table 2. The personnel structure, position type, and pay scale for the Klamath Network. 4

Table 3. Data categories with examples of products that could be potentially created as part of an inventory or monitoring project. 7

Table 4. General data management activities and the roles of the individuals who are responsible for those activities (adapted from Wilder 2005). 12

Table 5. The roles and data management responsibilities of personnel working with data on a project funded or developed by the Klamath Network (adapted from GRYN 2005). 13

Table 6. Categories of data that will be managed during an I&M project. 31

Table 7. Metadata parsing strategy. 57

Appendixes

Appendix A. Metadata interview form 82

Appendix B. Data certification form 86

Appendix C. Log books with examples 88

Appendix D. Example data dictionary 92

Appendix E. Required photograph metadata 93

Executive Summary

The overall mission of the U.S. National Park Service is to conserve natural resources in a manner that leaves them unimpaired for future generations. To help meet this goal, park managers need to have the most up-to-date scientific information available about the status and trends of natural resources within the parks. The interactions among natural resources create a complex ecosystem that is difficult to track and monitor. Abiotic, biotic, and dynamic influences that span spatial and temporal scales make it complicated to predict the overall effect that activities within and outside the parks may be having on those resources. The overriding objective of the Inventory and Monitoring Program is to select key resources within the parks and monitor those resources to make available status and trend information to park managers. Providing high quality information about natural resources will help park managers meet their goals and support the overall mission of the National Park Service.

A solid and comprehensive data management program that takes into account the complexities of long-term natural resource monitoring is essential to accession, storage, and dissemination of quality information to support the management of park ecosystems. The main objective of the Klamath Inventory and Monitoring Network's (KLMN) Data Management Program is to incorporate practical and sound data management methods into the Network's projects so we can provide quality information over time. Long-term data management must take into account changing technology, developing field methodologies, and most importantly, turnover in personnel. Developing a data management program where every employee understands the roles and responsibilities he or she has towards data management throughout all phases of a project is essential to obtaining quality information. We developed the KLMN Data Management Plan to provide guidance on how data and information will be managed for the foreseeable future. The overall goals of this Data Management Plan are to ensure:

- Every individual working for the Network understands his or her responsibilities towards data management.
- Data managed by the Network are of high quality, easily accessible, well documented, and secure not only for the duration of a project, but also for future generations that may utilize the information.
- Direction is provided on integrating proper data management practices throughout all phases of a short or long-term project from planning through archiving.
- Collaboration occurs at all levels of the agency and with external cooperators on data management issues.

The Klamath Network Data Management Plan is not intended to provide all the details on how to manage data for every task we implement. The Data Management Plan is a comprehensive document outlining the processes and guidelines the KLMN will follow to provide high quality, useable natural resource information over time. The KLMN implements the Data Management Plan, standard operating procedures, protocols, and guidance documents to provide all the details on how the Network collects and manages natural resource information. This document describes:

- The goals and objectives of the KLMN Data Management Program.

- The roles and responsibilities each member of the Network has towards data management throughout each phase of a project.
- How KLMN personnel will prioritize our time and funding towards data management activities based on information needs outlined in monitoring protocols and inventory projects.
- Details of the infrastructure the Network will utilize to create, store, maintain, and disseminate data and information.
- The methods the KLMN will follow to manage data throughout all phases of the data lifecycle.

Acknowledgements

Prior to developing this document, 17 NPS Inventory and Monitoring Networks had completed or were in the final stages of completing data management plans. Much of the material in this plan was developed from information and insight provided by Data Managers in those networks. It is difficult to give credit to specific individuals because of the significant amount of collaboration that went into developing those plans. The Klamath Network would like to thank all participants in those 17 networks whose work was valuable in developing our Data Management Plan. Specifically, seven data management plans were used extensively in the development of our plan and we would like to send our appreciation to the authors of those plans: Doug Wilder (Central Alaska Network); Rob Daley (Greater Yellowstone Network); John Boetsch, Bret Christoe, and Ronald Holmes (North Coast and Cascades Network); Geoff Sanders (National Capital Region Network); Nicole Tancreto (Southern Colorado Plateau Network); Dorothy Mortenson (Southwest Alaska Network); and Leona Svancara (Upper Columbia Basin Network). The organization, detail, and content of these Data Management Plans were commendable and greatly helpful. In addition, we would like to give thanks to the former KLMN Data Manager Robert Truitt (Mojave Network). We appreciate the ground work you laid to help us outline and complete our Data Management Plan. Finally, I want to give thanks to park and Network staff who spent valuable time reviewing and editing this document. For this effort, our thanks go out to: Laura Bridy, Elizabeth Perry, and Daniel Sarr.

Introduction

Since 1916, the mission of the U.S. National Park Service (NPS) has been "…*to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations"* (National Park Service Organic Act, 1916).

Chapter 4 of the 2006 NPS Management Policies states, *"The National Park Service will strive to understand, maintain, restore, and protect the inherent integrity of the natural resources, process, systems, and values of the parks."* This policy, 90 years after the Organic Act, continues to stress that one of park managers' core responsibilities is to preserve park resources, and their associated values, in their natural state for future generations. Through a well-maintained data management program, inventories of park-related natural resource data, and a long-term natural resource monitoring program, the Klamath Inventory and Monitoring Network ("KLMN" or "the Network") can provide park managers with up-to-date scientific knowledge and tools to help them better understand and manage the parks' ecosystems. The objective of this Data Management Plan (DMP) is to provide a guideline that the KLMN will follow in order to manage all aspects of ecological data maintained by the Network.

The Inventory and Monitoring Program

In 1998, the National Parks Omnibus Management Act created a framework for the Inventory and Monitoring Program which fully integrates natural resource monitoring and other scientific activities into the management process of the National Park System. Section 5934 of the Act requires the Secretary of the Interior to develop a program that establishes baseline data and long-term trend information on the condition of natural resources within the parks.

To carry out this mission, the NPS Inventory and Monitoring (I&M) Program was developed to provide support and funding to approximately 270 National Park units by conducting inventories and long-term monitoring of natural resources. The 270 park units have been divided into 32 "vital sign" networks of similar geography, natural resources, and resource protection challenges (Odion et al. 2005). Each network has been tasked with supporting the 12 basic inventories, developing and implementing a vital signs monitoring program, and preparing and implementing a detailed data management plan.

The long-term objectives of the I&M Program are to:

- Inventory the natural resources and park ecosystems under NPS stewardship to determine their nature and status.
- Monitor park ecosystems to better understand their dynamic nature and condition and to provide reference points for comparisons with other, altered environments.
- Establish natural resource inventory and monitoring as a standard practice throughout the NPS that transcends traditional program, activity, and funding boundaries.
- Integrate natural resource inventory and monitoring information into NPS planning, management, and decision making.
- Share NPS accomplishments and information with other natural resource organizations and form partnerships for attaining common goals and objectives (NPS - 75).

The Klamath Network

The KLMN encompasses six park units managed by the NPS in northern California and southern Oregon. Collectively, these six units comprise nearly 200,000 hectares and range considerably in size and elevation (Table 1). The parks within the Network span a region of complex topography that can be split from north to south into two geologically distinct subregions, the Klamath-Siskiyou (KS) and the Cascades-Modoc (CM) subregions. The Klamath-Siskiyou subregion extends eastward from California 0.5 km (0.25 mi) offshore in the Pacific Ocean to the edge of the Cascades foothills. The Cascades-Modoc subregion continues eastward into the Great Basin (Figure 1). The ecosystems of the Klamath Network are maintained by a complex biophysical environment composed of abiotic processes (climate, geology, and ocean characteristics), biotic processes (competition and predation), and temporal dynamics (disturbances) that span multiple spatial and temporal scales (Odion et al. 2005).

Table 1. The National Park Service units in the Klamath Network and their size, elevations above sea level, and subregional location.

Park Unit	Size (ha / acres)	Elevation (m)	Subregion
Crater Lake National Park	73,775 / 182,298	1219-2720	CM
Lassen Volcanic National Park	43,047 / 106,369	1585-3187	CM
Lava Beds National Monument	18,898 / 46,697	1200-1685	CM
Oregon Caves National Monument	196 / 484	1122-1670	KS
Redwood National and State Parks	42,700 / 105,469	0-996*	KS
Whiskeytown National Recreation Area	17,614 / 43,524	244-1893	KS

*The subtidal zone at Redwood National Park extends 0.5 km offshore to an unknown depth below mean sea level.

The USDA Forest Service and USDI Bureau of Land Management have jurisdiction over most lands bordering the park units. There are also a number of other agencies and non-profit groups managing and protecting lands within the Klamath region, such as the California Department of Fish and Game (CDFG), The Nature Conservancy (TNC), and Oregon Department of Fish and Wildlife (ODFW). To efficiently use all resources available to the KLMN, interagency collaboration is essential. This will enable the Klamath Network to compare status and trends in its vital signs not only within NPS management units, but also in surrounding units managed by other state and federal agencies, giving us information that may be indicative of regional ecosystem trends that are important in facilitating ecosystem management (Odion et al. 2005).

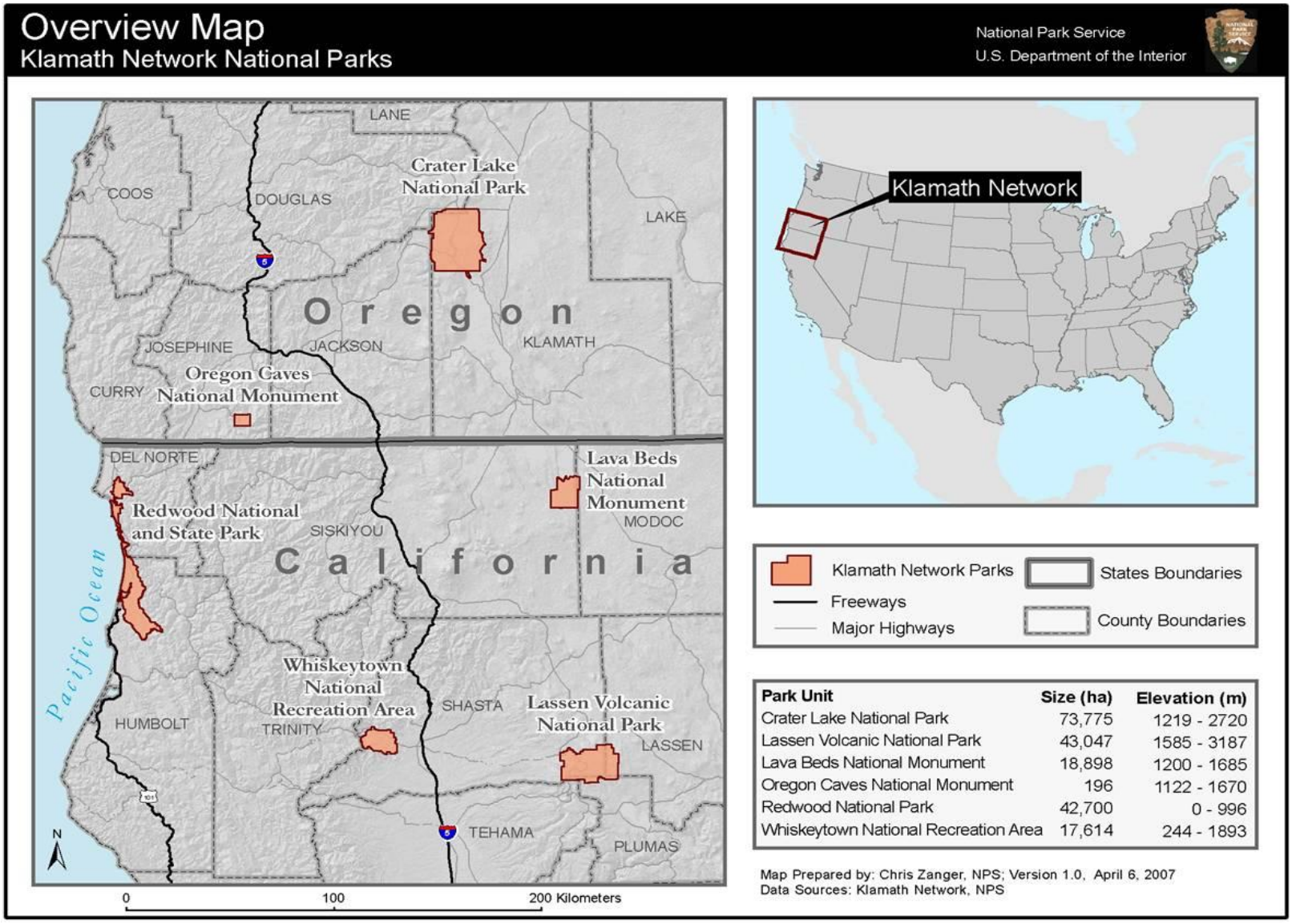

Figure 1. The National Park units within the KLMN located in southern Oregon and northern California.

Network Staff

The KLMN headquarters are located on the campus of Southern Oregon University (SOU) in Ashland, Oregon. Four positions compose the "core staff" of the KLMN, including three technical professionals: the Network Coordinator, Data Manager, and Aquatic Ecologist; and the Program Assistant, who plays a support role for all three technical professionals (Figure 2). The three technical professional staff positions share responsibility for vital signs planning and, together with affiliated park staff and cooperators, will implement the program. The staffing structure has been designed around the expertise requirements necessary to design, execute, evaluate, and report a vital signs monitoring program that encompassed terrestrial, subterranean, freshwater, and marine ecosystems (Sarr et al 2007). The projected operational staff for the KLMN is shown in Table 2. In addition, the Board of Directors (BOD), Technical Advisory Committee (TAC), and Subject Expert Workgroups (SEW) help provide guidance and support to the program.

Table 2. The personnel structure, position type, and pay scale for the Klamath Network.

Position	Position Type	GS Level
Network Coordinator*	NPS Permanent	GS - 12
Network Data Manager*	NPS Permanent	GS - 11
Aquatic Ecologist	NPS Term w/ possibility of Perm	GS – 09/11
Program Management Assistant*	NPS Term w/ possibility of Perm	GS – 06/07
Project Crew Leader (3)	NPS Seasonal	GS - 07
Project Crew Members(7)	NPS Seasonal	GS - 05
GIS Specialist*	Contract / Agreement	NA
Statistician or Biometrician*	Contract / Agreement	NA

*Staff currently working for the Klamath Network as of August 1, 2007.

The Board of Directors

The Network's oversight is provided by the BOD, consisting of the Superintendents from the six Network park units, two Resource Chiefs on an annual rotation, and the Coordinator of the Pacific Northwest Region Cooperative Ecosystem Studies Unit (PNW CESU). The Pacific West Region I&M Coordinator and the Network Coordinator are ex officio members of the Board. The BOD is chaired by one of the six Superintendents; a term as chairperson lasts two years. Every Superintendent must serve a term before any are eligible to serve a second term.

Technical Advisory Committee

The Network's TAC is made up of the six Resource Chiefs, the Network Coordinator, and the Network Data Manager. The TAC coordinates the Klamath Network activities and provides decision points to the BOD. In addition, the TAC imparts guidance to the Subject Expert Workgroup. The Network Coordinator is responsible for convening regular meetings and inviting other park staff, partners, and contributors as dictated by the meeting agenda.

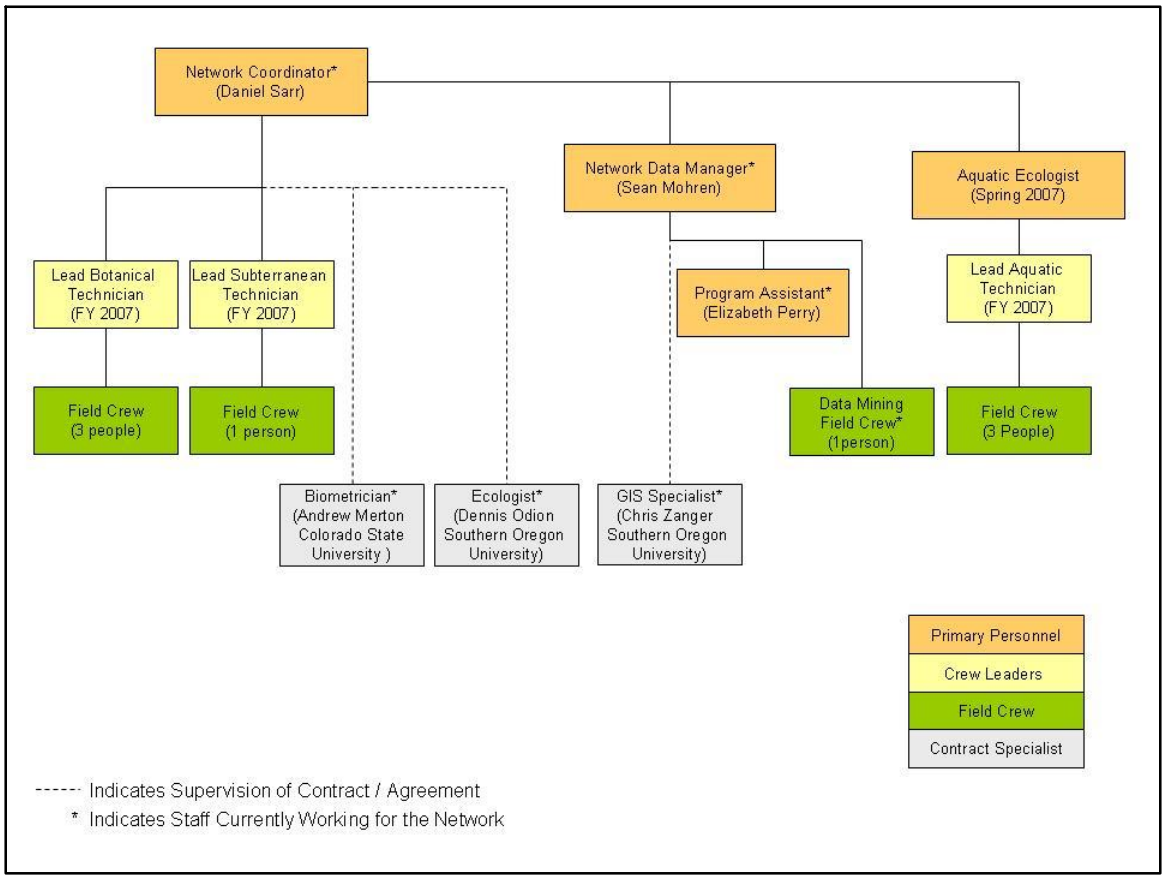

Figure 2. The personnel and supervisory structure for the Klamath Inventory and Monitoring Network.

Subject Expert Workgroup

The SEWs are composed of subject experts and interested personnel who provide advice to the Technical Advisory Committee on particular topics. The groups are primarily composed of personnel selected from the Network parks and allied federal agencies in the area. Nonfederal specialists from state agencies, neighboring universities, or nonprofit organizations are also invited to participate in meetings on an ad hoc basis.

Scope and Objective of the Data Management Plan

The DMP is a comprehensive document outlining the processes and guidelines the KLMN will follow to provide high quality, useable natural resource information over time. This plan is a critical first step in designing a sustainable KLMN Data Management Program that will be implemented to provide data and information over time. The Data Management Plan describes the processes used to manage data during project planning, data acquisition and analysis, information dissemination, storage, and archival of project materials. The success of the Klamath Network Data Management Program is dependent upon achieving the following six goals:

- **Data collected and managed by the Network are of high quality**. To ensure park staff is able to utilize the data managed by the Network, the data must be accurate and complete. Appropriate quality assurance and quality control (QA/QC) processes will be implemented throughout all phases of a project.

- **Data managed by the Network are readily available.** Information products will be distributed to park employees on a regular basis to keep them informed of KLMN activities. In addition, the Klamath Network will maintain both an intranet and internet website that will give the parks' staff and the public access to various reports and documents. Finally, the KLMN will utilize Service-wide data management products to distribute spatial data and metadata.

- **Data managed by the Network will be easily interpreted.** Coded datasets are confusing and can be easily misinterpreted. Without documentation discussing the intended use of the data, collection methods, date collected, accuracy, and location, a user can easily become perplexed and quite possibly misled about the usefulness of the data. Therefore, datasets managed by the Klamath Network will contain all documentation prior to dissemination.

- **Data stored and disseminated by the Network are secure.** Data managed by the Network will be screened for sensitive information prior to release. In addition, standard procedures for data storage, archiving, and versioning will be developed to maintain long-term data needs.

- **Educate staff working for or with the KLMN about data management principles and practices.** An import element of a data management system is the education of its different users. Therefore, the Network will work to ensure current and future staff members are aware of and follow documented data management procedures. The Network will also work with park staff, contractors, and seasonal employees to make sure they are familiar with current data management processes.

- **Work with park staff to ensure that data managed by the Network are accurate and up-to-date.** The Network will need to be in constant communication with the parks that makeup the Network. The KLMN needs to be continually made aware of the data and products available to them through the parks. Likewise, the KLMN needs to ensure park staff are aware of the tools and data available for their parks.

The main body of this document will provide general information and directions for data management activities required by the Network. Many of the data management methods will be dependent on the individual projects. Standard operating procedures (SOP), protocols, and guideline documents will be developed as the Network begins the monitoring aspect of the program. These documents provide the details on how to manage data for each monitoring or inventory project. As these documents are completed, they will be posted on the KLMN websites. When possible, we will try to

utilize as many of the same SOPs and guidelines for each project in an attempt to keep methodologies consistent. It is the intention of this DMP to be easily adapted to all KLMN natural resource projects.

Types of Data Covered by this Plan

In general, when conducting a natural resource project, field crews collect a set of quantitative and qualitative variables typically known as "raw data." These data are then processed, analyzed, and generalized to become "information" used to write reports, run analysis, create maps, and develop brochures. For the purpose of this document, we are describing "data" in the broadest sense. Data can mean anything ranging from raw data collected in the field to processed data used to create charts and statistical analyses. Data can also refer to the documentation that was developed based on the raw data and may include metadata, reports, presentations, and the administrative record (Table 3).

Table 3. Data categories with examples of products that could be potentially created as part of an inventory or monitoring project.

Data Category	Examples
Raw Data	Field forms and notebooks, photographs, digital data (sound/video recordings, GPS data, probe data, data loggers, telemetry data)
Derived Data	Relational databases, GIS layers, maps, analyses
Documents	Protocols, data dictionaries, FGDC / NBII metadata, photograph log
Reports	Progress reports, scientific publications, annual reports
Administrative Records	Contracts, agreements, study plans, permits and applications

Sources of Data

The majority of the data managed by the Klamath Network comes from inventory and monitoring projects conducted or funded by the Network. The Klamath Network has worked with NPS regional and park staff, natural resource specialists, and regional scientists to select 10 "vital signs" to fund and monitor. The vital signs selected to monitor effects on ecological integrity are factors that reflect the park ecosystem's structure (referring to the organization or pattern of the system), function (referring to ecological processes), and composition (referring to the variety of elements in the system) (Sarr et al. 2007). They are a subset of the total suite of natural resources that park managers are directed to preserve unimpaired for future generations and include:

- Non-native, invasive species
- Whitebark pine
- Terrestrial vegetation
- Landbird communities
- Intertidal communities

- Aquatic communities
- Cave entrances
- Water quality
- Land cover
- Cave environmental conditions

In addition to the 10 funded vital signs selected by the parks, it was also felt that climate monitoring is well-addressed by existing park climate stations and synoptic scale monitoring conducted by the National Weather Service, Western Regional Climate Center, and other entities. Similarly, air quality was considered to be very important, but the Network felt that the efforts of the existing Air Resources Program were equal to our current information needs. Therefore, climate and air quality have been designated as unfunded vital signs; their trends will be periodically summarized in collaboration with the appropriate sampling organizations.

The National I&M Program have designated 12 basic inventories that provide a wealth of information about the parks in our Network. The Klamath Network will work with the national I&M staff to ensure the following inventories are completed:

- Natural resource bibliography
- Base cartographic data
- Geology map
- Soils map
- Climate data
- Air quality
- Location of air quality monitoring stations
- Water body locations and classification
- Water quality data
- Vegetation mapping
- Species list for vertebrates and vascular plants
- Species distribution and status for vertebrates and vascular plant

Additionally, the Network is compiling data from a variety of regional and national level NPS sources, other government agencies, universities, and non-government organizations to provide information that will support the I&M Program and park management needs. Data are obtained from a variety of sources, including (Boetsch et al. 2005):

- Inventories
- Monitoring studies
- Protocol development pilot studies
- Focus studies by internal staff, park staff, contractors, and cooperators
- Research projects
- Resource impact evaluations
- Restoration projects
- Published scientific literature

The prospects for obtaining high quality data are best when good data management practices occur in all phases of a project, therefore the KLMN will place an emphasis on providing data management support for projects that are in the beginning stages. As time, necessity, and funding permit, the Network will attempt to incorporate our data management methodologies into the conversion of legacy data from completed projects.

Audience

The intended audiences of this Data Management Plan are:

- Park and Klamath Network I&M staff
- Individuals, agencies, and cooperators that participate in KLMN programs

While this plan is directed towards the immediate needs of the KLMN, the principles and guidelines provided can be applied to almost any data gathered by an agency, contractor, or additional sources. We intend for this plan to be informative, useful, accessible, and continually improving through time. While the KLMN Data Manager is the primary author and editor of this document, the involvement of end users in refining and improving these ideas is essential.

Plan Revisions

As a dynamic document, the Data Management Plan will change as sampling methodologies improve, technology advances, and more up-to-date information becomes available. The main document will undergo a full review three years after implementation. Following the three year review, the Network will conduct a complete review every five years, with minor updates being completed as needed.

A revision log will be maintained and updated with the main body of this document. The log will record a short description of the revision, what sections were revised, what date the revisions were made, and the current version number. Each minor revision will be represented by an incremental increase by hundredths (e.g. 1.01 vs. 1.02). Each major revision will include an update of the whole number (e.g. 1.01 vs. 2.00).

The most current version of the DMP is posted on the Klamath Network internet website at:

http://www.nature.nps.gov/im/units/klmn/index.cfm

and the KLMN intranet website at:

http://www1.nrintra.nps.gov/im/units/klmn/index.cfm

Roles and Responsibilities

The National I&M Program recognizes the importance of collecting data in a scientifically credible manner so the data can be used to address current and future management issues. The Klamath Network is expected to invest a minimum of 30% of our overall time into data management. To implement an effective data management strategy it is important to ensure each person working for the Network understand what role they play in data management.

It is important to recognize that every person working for Klamath Network will have some data management responsibilities. Each individual participating in data management needs to understand the flow of data through all phases of an inventory or monitoring project (Table 4). As the demand for high quality, detailed data about natural resources and their role in the environment continues to increase, well-managed data becomes imperative. It is crucial to an effective data management program that all employees are aware of the roles they play and their responsibilities as data stewards in those roles (Table 5).

A ***role*** is a position
(e.g., project leader)

A ***responsibility*** is a duty
(e.g., training, data validation)

The small number of staff at the Klamath Network makes it necessary to have individuals participate in more than one role within the Network. As such, understanding the responsibilities associated with the various roles in the Network will be essential. The KLMN will make every attempt to examine the skill sets of each employee and utilize his or her skills to help the Network reach our goals while at the same time providing the employee with valuable development opportunities.

Personnel Responsibilities

Long-term monitoring data can become very complex and thus it must be managed in a manner that coincides with constantly changing technology and increased scientific knowledge. Furthermore, long-term monitoring projects can outlive the staff that is currently dedicated to those projects. These factors make data management a difficult task that goes far beyond any one individual. While everyone who plays a role in the Network has some data management responsibilities (Table 5), the primary data management tasks revolve around a core team composed of the Data Manager, GIS Specialist, and Project Manager. It is the core data management team's responsibility to work in conjunction with each other to provide the most accurate and useable information available.

Table 4. General data management activities and the roles of the individuals who are responsible for those activities (adapted from Wilder 2005).

Data Management Activity	Tasks	Personnel Involved
Planning	• Project Development • Goals and Objectives • Protocol, SOP, Attribute Selection • Spatial Data Selection • Folder and Project Record Development	• Network Coordinator • Data Manager • Project Manager • GIS Specialist • Program Assistant
Data Design	• Database Design • Datasheet Design • Database Documentation • Data Dictionary and Metadata Development	• Data Manager • Project Manager • GIS Specialist • Project Crew Leader • Program Assistant
Training (database, collection methods, documentation)	• Database Training • Data Collection Methodologies • Data Dictionary and Metadata Development • Equipment Use	• Data Manager • Project Manager • GIS Specialist • Crew Leader / Crew
Data Acquisition and Quality Control	• Data Collection • Data Entry • Data Verification / Validation • Consistency Testing of Field Data	• Data Manager • Project Manager • GIS Specialist • Crew Leader / Field Crew
Quality Assurances, Analysis, Data Summaries	• Data Validation • Automated Data Summaries • Data Analysis	• Data Manager • Project Manager • GIS Specialist
Documentation	• Data Quality Documentation • FGDC / NBII Compliant Metadata • Reports, Publications, Summaries	• Data Manager • Project Manager • GIS Specialist
Access & Archiving	• Complete Metadata • Archive Data • Catalog Data / Reports • Distribute Information • Provide Access to Data / Reports	• Data Manager • GIS Specialist • Program Assistant • Project Manager

Table 5. The roles and data management responsibilities of personnel working with data on a project funded or developed by the Klamath Network (adapted from Daley 2005).

Role	Data Responsibilities
Project Crew Member	• Collect, enter, and verify data • Document and report issues with data collection, data entry, and QA/QC process to the Crew Leader
Project Crew Leader	• Train and supervise field crews • Organize and verify data • Report issues with data collection or documentation to the Project Manager
Project Manager	• Supervise Project Crews • Train Project Crew Leader on proper data management • Validate data • Provide data documentation • Convert data into information • Implement protocols and SOPs • Evaluate project-related data management methodologies
Network GIS Specialist	• Process, manage, and validate spatial data • Make spatial data accessible and useable • Conduct spatial analysis • Work with Data Manager to integrate spatial and tabular data • Manage GPS data • Train Project Manager on proper data management
Network Program Assistant	• Works with the Data Manager, Project Manager, and Network Coordinator to keep the project records in the project database and national I&M databases current. • Incorporates all photographs and associated metadata into the KLMN Photograph Database. • Ensures that documentation for databases, maps, and project information accompanies information posted on the KLMN internet and/or intranet websites.
Network Data Manager	• Develop and support a network data management system • Ensure KLMN managed data are organized, documented, accessible, and safe • Train staff in proper data management methodology • Make certain data and information is properly archived • Provide guidance and standards for data sharing and access to sensitive data • Develop and maintain the Network websites
Network Coordinator	• Coordinate and oversee all network activities • Review and approve all network-generated reports, including reviewing internal protocols and obtaining policy review for all relevant network documents • Work with the Data Manager to ensure data is collected, documented, and stored in a manner that supports the Network
Information Technology Specialist	• Provide support for all hardware, software, and networking
Park Curator	• Oversee all aspects of specimen acquisition, preservation, and documentation • Manage the collections for parks in KLMN jurisdiction

Table 5 (continued)

Park Resource Managers	• Provide technical assistance and advice for implementing KLMN goals and objectives • Integrate information provided by KLMN into park planning and management decisions
Superintendents	• Provide advice regarding the long-term goals and objectives of the Klamath Network data management process that will prove useful to park managers • Integrate information provided by KLMN into park planning and management decisions
I&M Data Manager (National Level)	• Provide Service-wide support

Network Coordinator

The Network Coordinator oversees all aspects of the Klamath Inventory and Monitoring Network, including data management. The person in this role supervises and directs the core staff at the KLMN. General responsibilities include:

- Supervises the Klamath Network staff, as well as all Project Managers associated with a project funded by the Network.
- Responsible for overseeing and authorizing the administrative tasks of each project, including task agreements, contracts, budgets, and personnel.
- Responsible for reviewing and approving all network-generated reports and protocols and for obtaining policy review for all relevant network documents.
- The Network Coordinator works closely with the Project Manager, Data Manager, and other support staff to make certain that data managed by the Network is accurate, complete, and accessible.
- Creates network-related policies, guidelines, standards, and procedures.

Data Manager

The Data Manager develops, refines, and directs a complex program of data management activities within the Network. The person in this role has the overall responsibility for all data managed by the Network. It is the duty of the Data Manager to provide guidance and standards to everyone involved in data management. Primary responsibilities include:

- Creates data management-related policies, guidelines, standards, and procedures.
- Designs, implements, supports, and manages database systems for long-term monitoring projects, inventory projects, and various other I&M activities.
- Provides coordination, training, technical assistance, and professional advice to meet the data management needs of the staff.
- Works with the GIS Specialist to integrate tabular and spatial data to meet project and network objectives.

The ***Data Manager*** has the overall responsibility for all data managed by the Network

- Works with the park staff to document legacy data and to ensure that relevant and useful data are acquired and integrated into the KLMN program's databases when applicable.
- Provides access and security to data and information managed by the Network.
- Makes available appropriate documentation of data.

GIS Specialist

The GIS Specialist is responsible for the development, coordination, and implementation of the spatial systems and products for the Network. Specific responsibilities include:

- Determines the GIS data and analysis needs for individual projects.
- Develops procedures for field collection of spatial and Global Positioning System (GPS) data and techniques.
- Conducts spatial analysis of project-related data.
- Documents data in compliance with NPS, Federal Geographic Data Committee (FGDC), and National Biological Information Infrastructure (NBII) metadata standards.
- Negotiates cooperative and interagency agreements to effectively carry out the GIS program to meet data management goals.
- Creates products and presentations that can be used for outreach and interpretive programs to help educate staff, government employees, the scientific community, and the public about the Network and our goals, objectives, and accomplishments.
- Establishes and implements procedures to protect and disseminate sensitive spatial data according to project needs.

Project Manager

The Project Manager is responsible for all phases of an inventory and monitoring project. The person in this role works closely with the Network Coordinator, Data Manager, GIS Specialist, and field crew members to ensure data management protocols, SOPs, and guidelines are being followed. It is one of the Project Manager's core responsibilities to make sure information collected in the field is accurate, complete, and correctly documented. Overall data management duties of the Project Manager are:

- Develops and implements, in close collaboration with the Network Coordinator and Data Manager, the protocols, standard operating procedures, and sampling methodologies for each project.
- Supervises and certifies all field operations including training, equipment handling, data collection and entry, QA/QC measures, verification, and validation.
- Transfers data to the Data Manager on a schedule determined during the planning phase of a project.
- Documents all field activities that relate to data management.
- Works with the Data Manager and Network Coordinator to determine workload priorities, timelines, summaries and final reports, and deadlines.
- Serves as the point of contact for all data collection issues on the projects he or she manages.

Collaborative Duties

Throughout the development and implementation of KLMN-funded projects, there are several duties that members of the core data management team (Data Manager, Project Manager, and GIS Specialist) will need to work closely together to perform (Figure 3). These additional responsibilities include:

- Develop quality control and quality assurance measures and methodologies for individual projects.
- Document all data collected for a project including reports, metadata, and data dictionaries.
- Determine methodologies for data collection, entry, quality control, transfer, storage, and dissemination for each project.
- Identify sensitive project information and develops levels of access to and timelines for dissemination of that information.
- Coordinate changes to any aspects of a project including collection methodologies, data forms, data entry, storage procedures, and databases.
- Develop user-friendly interfaces for data entry that incorporate quality control measures.
- Determine information needs that will be required by the end-user.

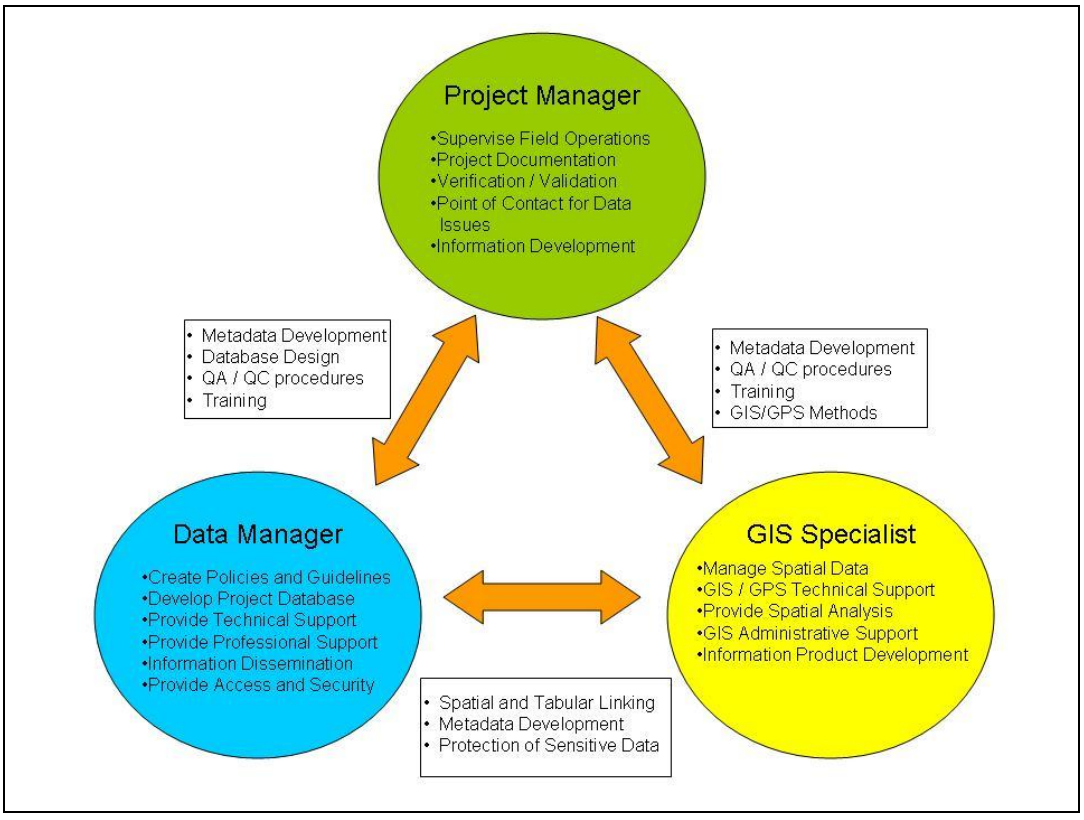

Figure 3. Breakdown of the roles, duties, and combined responsibilities of the core data management team members (adapted from Tancreto and Hendrie 2006).

Program Assistant

The Program Assistant will work closely with all personnel involved in a project to provide support in a variety of administrative and data management duties. Responsibilities include:

- Assists the Data Manager with the maintenance of the KLMN intranet and internet websites.
- Works with Project Managers to provide administrative support for all aspects of a project, including but not limited to payroll, logistics, purchasing, contracts, agreements, travel, etc.
- Understands and follows the Data Management Plan and SOPs, specifically in regards to disseminating documents or databases, naming and storing administrative records, and QA/QC processes.
- Works with the Data Manager to help in database development, storage, and archiving.
- Coordinates with the Network Coordinator to provide administrative support for all aspects of the Network, including but not limited to payroll, logistics, purchasing, travel, etc.
- Manages the project tracking database by coordinating with the Project Managers, Network Coordinator, and Data Manager to ensure everyone is aware of upcoming deadlines, the availability of project deliverables, and the overall status of a project.

Crew Leader

The Crew Leader is a key position in any project. The person in this role will be the most knowledgeable about how a project is being implemented in the field. The Crew Leader must work closely with the Project Manager in many of the data management activities to ensure their implementation and refinement, as necessary. The general responsibilities of the Crew Leader are:

- Works with the Project Manager to ensure field crews are properly trained on data management methods, equipment use, and sampling methodologies.
- Supervises field crew members to ensure that they consistently and accurately record data according to specified methods.
- Validates all data entered by field crews prior to transferring the information to the Project Manager.
- Reports data management issues (e.g., collection or entry methods, errors, GPS/GIS technology, etc.) to the Project Manager.
- Ensures metadata are made available for all data including photograph logs, training logs, datasheet logs, etc.
- Transfers all data materials to the Project Manager on a predetermined schedule.
- Works to ensure constant communication is maintained between the Project Manager and the person in this position.

Data Management Coordination

Chapter 4 of the 2006 NPS Management policies states *"The service will pursue opportunities to improve natural resource management with parks and across administrative boundaries by cooperating with public agencies, appropriate representatives of American Indian tribes and other traditionally associated peoples, and private landowners…the service will develop agreements with federal, tribal, state, and local governments and organizations; foreign governments and organizations; and private landowners, when appropriate, to coordinate plant, animal, water, and other natural resource management activities in ways that maintain and protect park resources and values."*

In order to achieve the goals of the Klamath I&M Network, cooperation and coordination with National I&M personnel, the other 31 "vital signs" networks, park staff, government agencies, universities, research organizations and other non-government agencies will be essential in the development of the KLMN Data Management Program.

Natural resources in the parks, and threats to them, do not adhere to political boundaries, therefore development of a well-organized data management program must facilitate science and foster partnerships among Data Managers, Coordinators, scientists, and other natural resource professionals throughout the NPS, scientific community, and other regional organizations.

Southern Oregon University

The NPS and SOU are both participants in the Pacific Northwest Cooperative Ecosystem Studies Unit, part of a nationwide network of similar units organized around bio-geographical regions for the purpose of providing high-quality scientific research, technical assistance, and education through the linking of participating agencies and university partnership. In 2004, the KLMN entered into a task agreement with SOU to establish an administrative office on the main campus, providing the program with access to the information technology, communication, and research capabilities of SOU. Within this agreement, SOU provides:

- A Principal Investigator to oversee all collaborative activities and to ensure that KLMN and SOU requirements are met.
- Facilities and infrastructure support including offices, laboratories, libraries, computer-related services, equipment, supplies, telephone services, and meeting rooms.

In return for SOU's services, the Klamath Network provides:

- Financial assistance on a yearly basis for the amount approved in the KLMN Annual Administrative Report and Work Plan.
- An Agreement Technical Representative (ATR) to collaborate with the University Principal Investigator.

- Involvement for faculty and students in research, internships, employment, and educational opportunities where appropriate and mutually beneficial.
- Staff to provide guidance and consultation with students and faculty as needed and appropriate with ongoing activities.

National Park Service

The Natural Resource Challenge, initiated in 1999, is a major initiative to bring scientific knowledge to the parks and the public to ensure that park managers have the best possible science at hand. As the flagship program of the Natural Resource Challenge, the Inventory and Monitoring Program will provide critical information to guide this process. This program is a compilation of 32 regional networks with a national office located in Fort Collins, Colorado.

National to Network: The National I&M Program staff have worked closely with the 32 regional networks to design and develop data management methodologies and tools. Tools include NPSpecies, NatureBib, Natural Resource Database Template (NRDT), GIS Theme Manager, and Dataset Catalog. The KLMN has also taken advantage of tools created by other divisions within the NPS, including NPSTORET, NPS Metadata Tools and Editor, NPS Database Metadata Extractor, NPS Data Store, Research Permit and Reporting System (RPRS), and the NR-GIS Clearinghouse. In addition, the National I&M Data Manager works to keep abreast of developing trends, innovations, guidelines, and educational opportunities in data management and communicates with Network Data Managers by various media.

Network to Network: Each of the 32 networks within the NPS Inventory & Monitoring Program is required to have at least one Data Manager. These Data Managers form a distributed community of working technical professionals that coordinate regularly through conference calls, regional and annual meetings, workgroups, list serves, websites, and one-on-one conversations. This communication is essential to provide the NPS with data that can be integrated and analyzed across multiple parks and networks. Frequent communication allows for the improvement in quality and efficiency in the development of data management methodologies, protocols, SOPs, and guideline documents. Communication among networks provides opportunities in technology sharing, idea development, cost efficiencies, and partnerships. In addition, the Regional Coordinator works with the networks within the Pacific West Region to review programmatic reports and protocols, develop regional data management goals and objectives, and works to keep networks within the region informed on data management activities, innovations, and guidelines.

Network to Park: In developing a data management program, it is important to keep the end users in mind at all stages of development. Ultimately, the KLMN program is designed to serve park managers and the public, with periodic contributions to the broader scientific community. Collaboration between the Klamath Network and the six parks within the Network, therefore, will be essential if the program is to succeed. The Board of Directors, Technical Advisory Committee, and Subject Expert Workgroups include primarily park-based staff, providing frequent forums to inform the parks about

key findings and to engage them in planning and analysis activities. Although I&M staff bear the responsibility for implementing the program day-to-day, we will collaborate closely with these working groups to make sure the needs of the parks are being met.

Infrastructure and Systems Architecture

Infrastructure refers to the basic structure or features needed to perform one's task and includes the computers and servers that KLMN relies on to store, maintain, and disseminate data. System architecture refers to the applications, repositories, and tools supported by the infrastructure that KLMN utilizes to manage data. In order to meet the overall goals of the I&M program, it is important to understand how the data managed by the Network will be stored, maintained, and distributed over the life of each project and for future users of the data. This chapter discusses the components of the Klamath Network system architecture and infrastructure needed to provided a lasting product that is distributed to a diverse group of users.

Infrastructure

Our Network relies heavily on park, regional, national, and university information technology (IT) personnel and resources to maintain the overall infrastructure of the Network. Southern Oregon University IT staff is responsible for server maintenance, security, software updates, telecommunication networks, and routine backup for the KLMN administrative office. NPS IT staff is responsible for maintaining computer hardware, providing software programs and updates, administrative functions, and security. The KLMN Data Management Program infrastructure must include the following elements and functions:

- A repository for active datasets, backups and archived data.
- Support for desktop, email, and internet applications.
- System and data stability and security.
- Functional telecommunication hardware and software.
- Relevant computer hardware and software.
- A means to upload and download data by the Network, parks, and public.

The file server infrastructure used by the KLMN includes remote servers maintained at the National NPS office and Southern Oregon University campus (Figure 4). These servers can be divided into five categories:

- Work File Server – A server available with read/write access to all KLMN staff where shared files are stored.
- Data File Server – A read-only repository of data files. Write access to these files is under strict control by the Data Manager and GIS Specialist. This server generally houses data from completed projects or field seasons, GIS data, and imagery.
- Database Servers – An enterprise level server that runs on a relational database management system (RDBMS) such as Structured Query Language (SQL) server, Oracle, or Arc Spatial Database Engine (ArcSDE).
- Application Server – Provides users access to applications that can be utilized to access data in the database or internet servers.

- Internet Server – This server provides various features associated with the internet including web page and database applications, data and information products, and photographs and imagery.

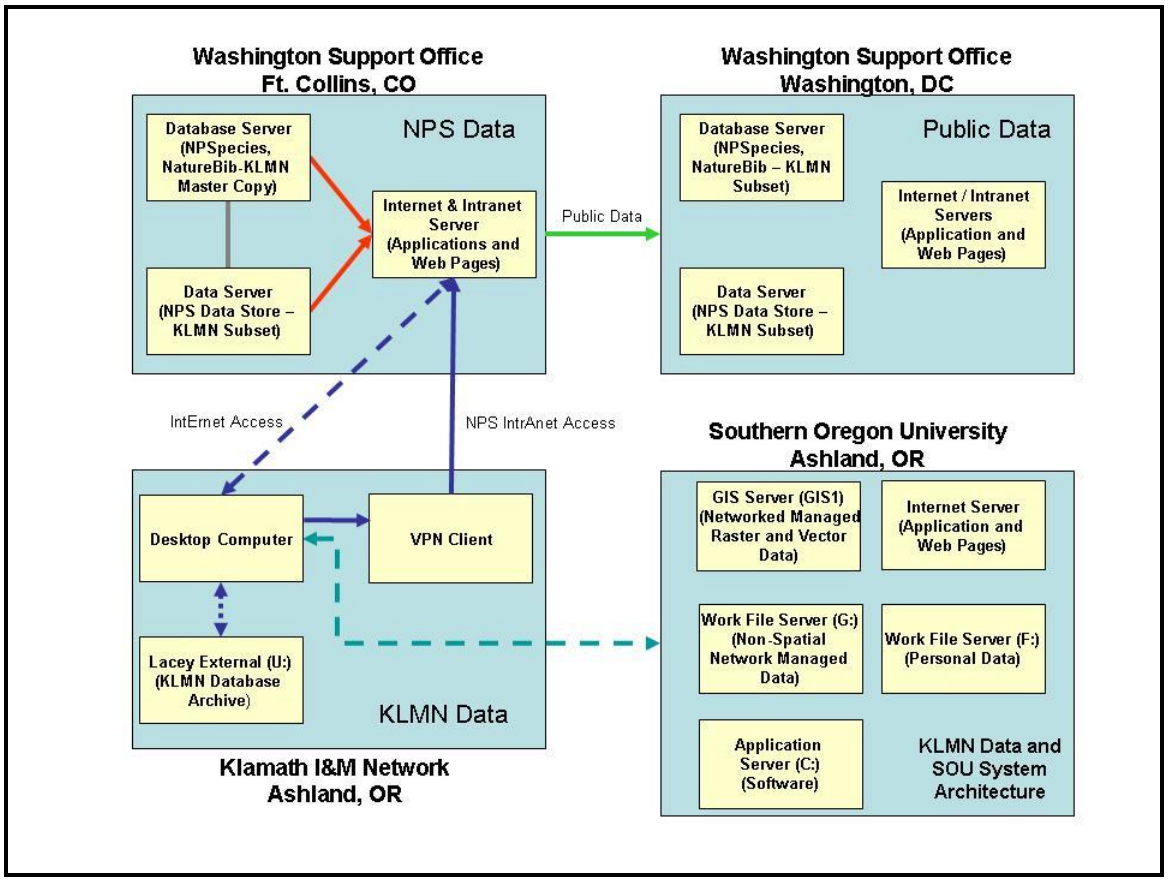

Figure 4. A schematic diagram of the infrastructure that the KLMN relies on for data management.

System Architecture

The systems architecture the KLMN relies on comes from a variety of sources including the Regional and National NPS offices and Southern Oregon University. The following sections discuss various components of the system architecture the KLMN will utilize for all our data management needs.

Data Management Software

Any software used to create information or manage data in the KLMN must be approved by the Data Manager prior to acquisition to ensure that it conforms to NPS standards and policies. As new products become available, the KLMN staff will determine each product's usefulness, and, when desired, incorporate those products into the Network system architecture. Current standard practices for the use of various programs for data management are listed below.

Word Processing: All documents created for the purpose of reporting data or information about a KLMN project will be finalized in Microsoft (MS) Word. Documents being distributed will be converted to a PDF format using the latest version of Adobe Acrobat. A copy of the report in Word and in PDF format should be saved in the project folder when applicable. Annual reports and analysis and synthesis reports should adhere to standards outlined in the *Data Analysis and Reporting* chapter.

Databases: All databases utilized to enter, store, or maintain data will be created in the latest version of MS Access. If a database other then MS Access is to be used, prior approval by the Data Manager is required. Databases should conform to the standard practices associated with the I&M NRDT.

GIS Products: GIS products must be compatible with ESRI ArcGIS software. GIS products will need to meet NPS and FGDC standards and be completely documented prior to dissemination or use in analysis.

The KLMN is currently in the process of working with SOU to develop an SQL server based system as a repository for I&M GIS data. It is the Data Manager's responsibility to work with the GIS Specialist and SOU IT personnel in managing this server. No GIS data will be incorporated into the server unless the data are accompanied with metadata.

Project Files

Currently, non-spatial data managed by the KLMN is stored on one network drive (G:) that can be accessed by all Network employees who have an SOU login account. The Network makes every attempt to name folders on the drive in a concise yet descriptive manner so users unfamiliar with the structure may easily adapt to the system. All folder names must follow the KLMN Naming Convention Guideline available on the KLMN intranet website. Prior to adding a new level one folder to the network drive one should consult the Data Manager to determine the best location for the folder. The KLMN manages a variety of level one (Figure 5) folders and the structure of each folder varies depending on its content. However, for the inventory, monitoring, and project folders, we will use a broad to fine scale structural approach that involves four levels (Figure 6).

Level 1: The first level (Figure 5) contains twelve folders of the broadest category listed in section 3.2 of the KLMN Drive Structure Guidelines. For project data, folders at this level are entitled Inventories, Monitoring, and Projects. The "Inventories" folder contains any inventories the KLMN funded or conducted. Similar to the "Inventories" folder, the "Monitoring" folder contains monitoring projects the KLMN has funded or conducted. The "Projects" folder contains projects that do not "fit" into either the inventory or monitoring category, such as research projects.

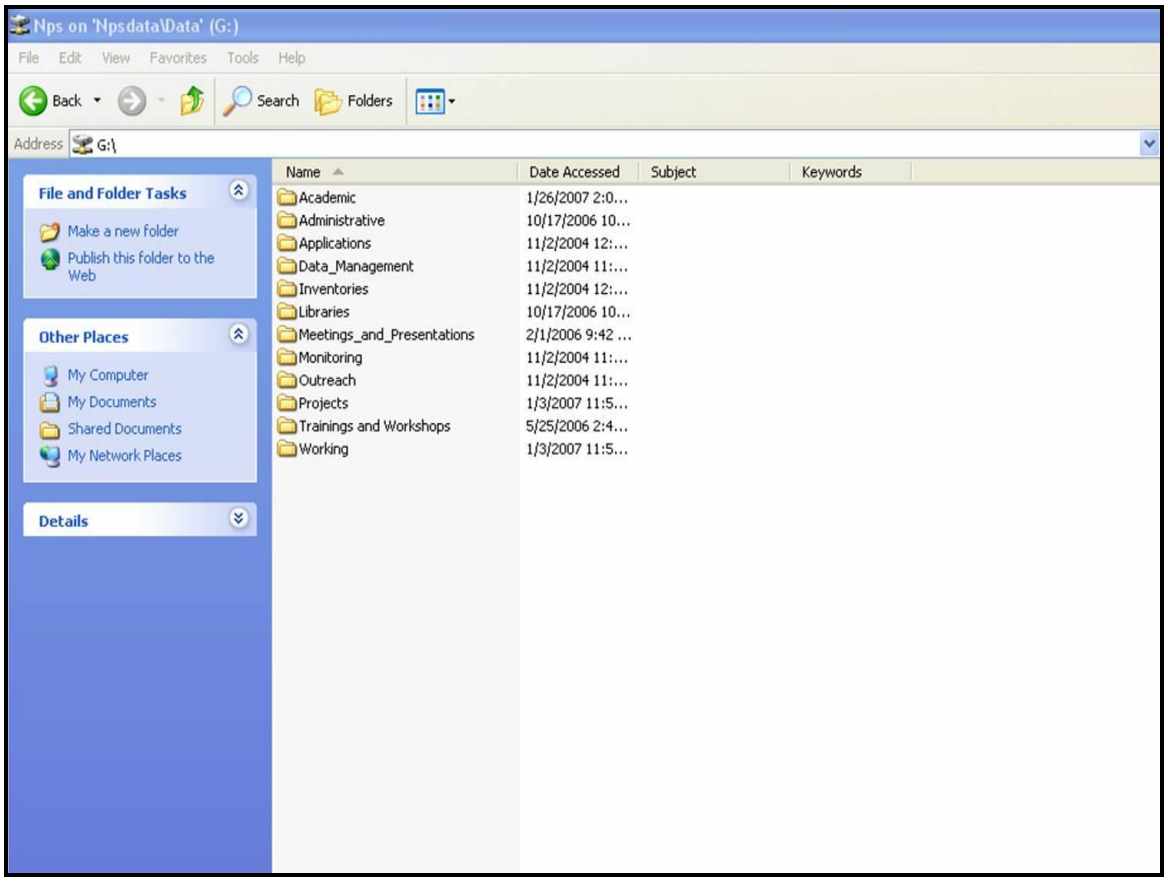

Figure 5. An example of the Level 1 folder structure for the network shared drive.

Level 2: The second level of folders in a project folder has and will continue to have a naming convention that includes the subject of the project and the type of project (Inventory, Monitoring, and Research). Some examples of folders at this level are Aspen_Research, Landbird_Monitoring, and Intertidal_Inventory. On the rare occasion that multiple projects of the same type on similar topics occur, the Data Manager and Project Manager will work together to develop a unique name for each project folder.

Level 3: The third level in the filing hierarchy is structured the same for all inventory, monitoring, and research projects. It contains five folders that each includes the project title and one of the following: Documents, GIS, Data, Images, or Analysis. These five folders will contain the data and information for each project. Subfolders may be used to help organize the data; however, this will be dependent on the project and will be defined as necessary.

- **Documents.** This folder contains the reports, budgets, work plans, emails, protocols, contracts, and agreements associated with a specific project.
- **GIS.** This folder contains any shapefiles, coverages, layer files, geodatabases, GPS files, GIS/GPS associated metadata, and spatial imagery associated with a project.

- **Data.** This folder contains non-spatial data collected in the field and its associated metadata.
- **Images.** This folder contains any photographs related to the project and an associated image log.
- **Analysis.** This folder contains derived data and associated metadata created during analysis.

Level 4: The fourth level contains the databases, spreadsheets, spatial data, photographs, and supporting documents for each project. Additional folders may be added to organize the materials that are stored in level four. For example, a folder could be created within the level three "Documents" folder called "Progress Reports" that will contain all the annual progress reports for a specific project.

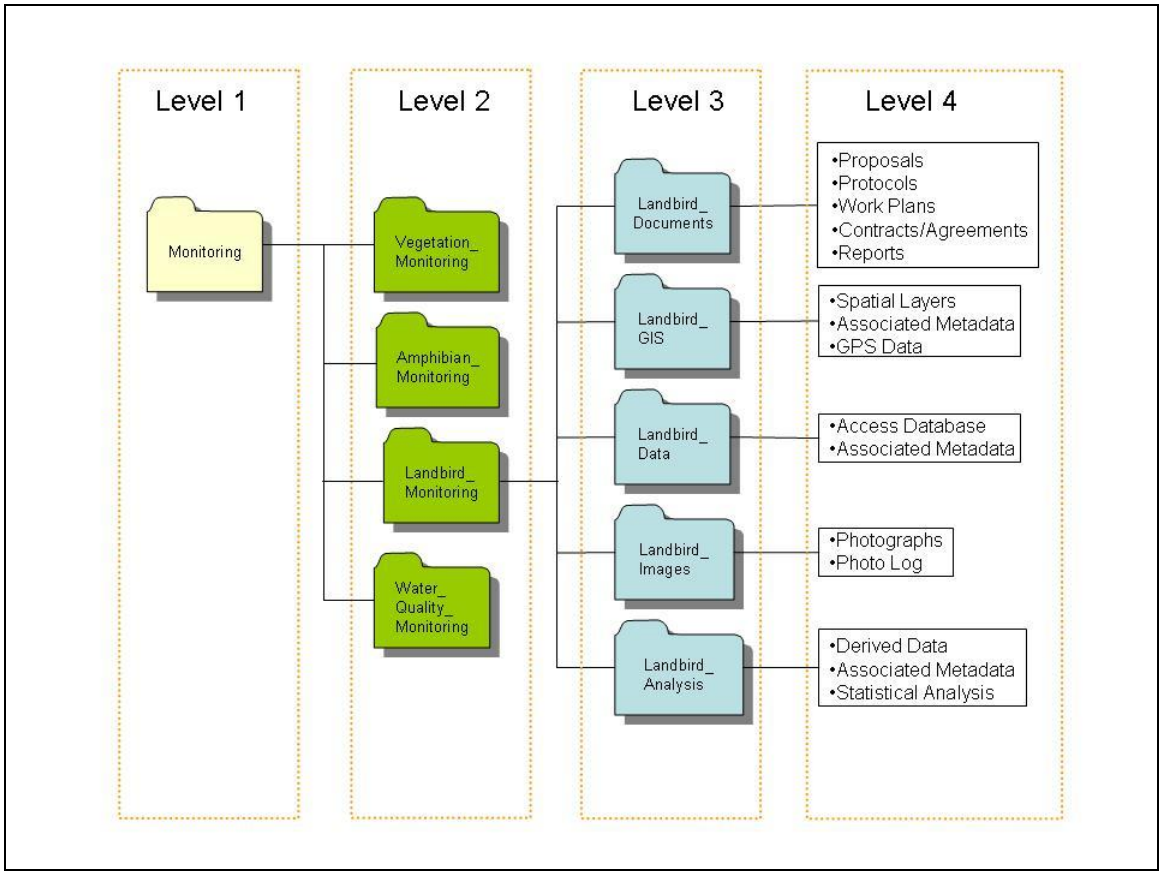

Figure 6. An example of the general file structure the KLMN will use to store and maintain inventory and monitoring project data.

Relational Database Structure

A relational database designed for scientific applications faces unique challenges not seen in traditional business-oriented database systems. Scientific databases must contend with the enormous variability in data sampling methodologies and measurement precision in specific projects (Michener et. al. 1994). It is not uncommon to have project goals and

objectives change over time so a database must be designed in a manner that makes it adaptable to change over the life of the project. Additionally, the 32 networks in the I&M Program adapt and utilize databases built by each other to reduce the amount of time, effort, and funding needed to develop multiple databases by a single network. Because we need to take into account that other networks may utilize and adapt a database we design, the Klamath Network will work to keep design methodologies as simple as possible, making them available to an audience that has a variable skill level in database development. When developing a database, it is important to answer four main questions:

- **Why do you need the database?** It is important to identify and address the primary need for a database. The project group must determine if the data are important enough to invest the resources necessary to develop and maintain a database. For our purposes, the Klamath Network requires all project data to be entered into a database when applicable.
- **Who is going to be the audience of the database?** Understand who will be utilizing the database will help determine the design and complexity of the databases.
- **What questions will the user expect to answer?** Understanding how users will want to summarize the data stored in the database is essential and should be addressed prior to development. A good rule of thumb is the designer should have a fairly clear concept of what the standardized reports will look like prior to developing the database.
- **How will you encourage the user to utilize the database?** It is import to define why someone will use the database. Determining the benefits a user will gain by utilizing a database will be essential to the present and future effectiveness of the database.

The KLMN will make every attempt to utilize databases that have already been developed for a monitoring project. If a database is not available, we will adapt the Klamath Network Natural Resource Database (KLMN NRD) to meet the needs of the project. The KLMN NRD is a MS Access database that uses variables specific to this Network and is modeled after the Version 3 Natural Resource Database Template developed by the National I&M office. More information on the KLMN NRD is below.

Natural Resource Database Template

The NPS Inventory and Monitoring Program's Natural Resource Database Template (NRDT) is a core relational database structure that can be modified and built upon by different parks and networks, depending on the components of their inventory and monitoring programs and the specific sampling protocols they use (Washington Support Office, 2004). As I&M networks develop monitoring protocols and databases, these will be made available through the national web-based monitoring protocol clearinghouse. Users may download a written protocol for some monitoring component (e.g., weather or bird counts) along with the database. The NRDT:

- Provides both a data interchange standard and a standard MS Access database core that allow flexibility in application design.

- Serves as a starting point for application development that can be extended as necessary to accommodate any inventory or monitoring field sampling protocol.
- Standardizes location and observation data to facilitate the integration of datasets.
- Acts as a design platform for developing database applications in MS Access, allowing users to enter, edit, display, summarize, and generate reports for inventory and/or monitoring datasets.
- Integrates with other I&M data management systems and data standards including the NPS Data Store, GIS tools and data, the NPS GIS Committee Data Layers Standard, and the NPS Metadata Profile.

Utilizing the NRDT and working with staff from Crater Lake National Park, the Klamath Network developed the KLMN NRD. The KLMN NRD represents a standardized set of database tables, structures, and field definitions, along with an associated user interface consisting of user-friendly displays, forms, reports, and queries, which may be used with a wide range of natural resource field data.

Klamath Network Natural Resources Database

The software and data structures comprising this database are contained within two separate but tightly coupled MS Access database files utilizing the Joint Engine Technology (JET) database manager. This design is a modification of the classic two-tier design and is commonly referred to as a "back-end" and "front-end." The classic two-tier design identifies separate database and user interface layers, whereas this design consists of a separate database layer and a mixed database/user interface layer through the use of linked database tables within the user interface layer. Figure 7 illustrates three connected back-end databases; however, the front-end can accommodate hundreds of compatible "back-end" databases (Klapatch, 2005).

The user interface encapsulates the Inventory and Monitoring recommended design, The Natural Resource Database Template Version 3 and the Klamath Network's Site Information Form. The user is presented with a number of interface displays to enter data, retrieve data, and perform some maintenance activities.

The KLMN will utilize the NRD whenever possible for all inventory, research, and monitoring projects funded by the Network. It is the Data Manager’s responsibility to adjust and develop the current database structure so that it meets all project objectives. When feasible, we will convert non-NRDT compliant databases used in several KLMN inventory and monitoring projects into the Network template at the end of each inventory project or monitoring field season. For more details on the KLMN NRD, refer to Klapatch 2005 and Klapatch and Truitt 2005.

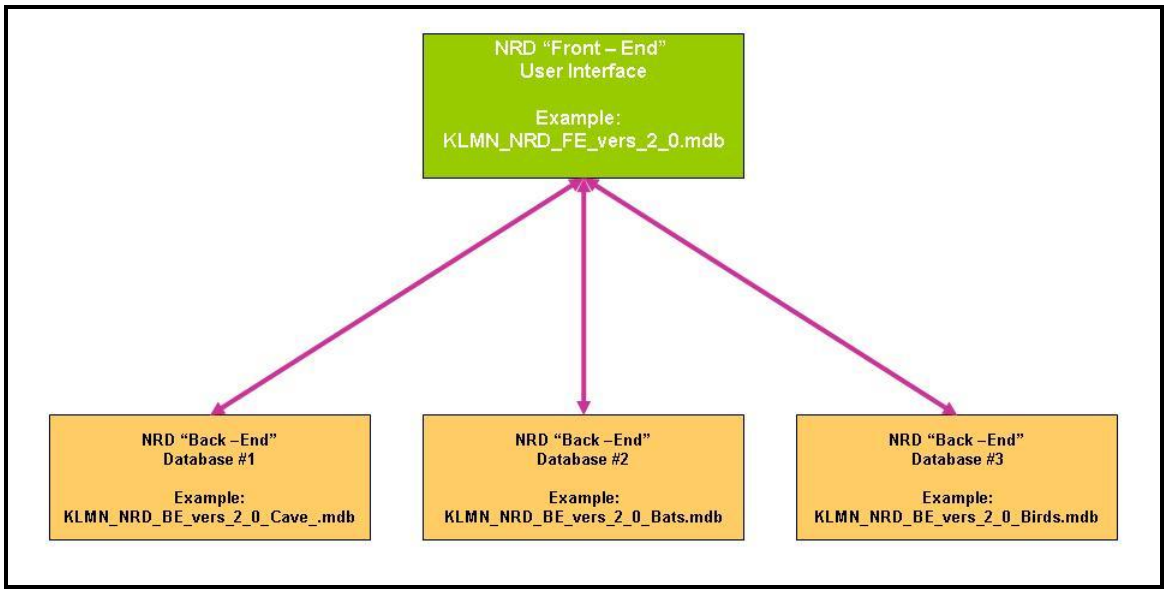

Figure 7. System overview of the KLMN natural resource database.

Master Data Library

The Data Manager is responsible for a master data library that stores project deliverables. Prior to incorporating data into the master library, all data must be properly documented and have passed QA/QC procedures outlined in the planning phase of each project. KLMN employees will have read-only access to the library; only the Data Manager will have write access.

The master data library will be backed up on a weekly and quarterly basis by Southern Oregon University. In addition, the Data Manager will backup the library as new products are added. The backup completed by the Data Manager will be stored on an internal hard drive located on the Data Manager's computer. The master data library will maintain a similar structure to the working project folder described in the *Project Files* section above.

Internet Servers

The KLMN Data Manager will work with the Program Assistant to provide information via the internet and intranet in a complete and timely manner. It will be the responsibility of the National NPS I&M office and Southern Oregon University to maintain the internet servers.

Information Technology Security

The KLMN will rely on the National and Regional NPS offices and Southern Oregon University to provide adequate security. Klamath Network staff will comply with all security procedures outlined by these agencies, including training as required.

Data Management Process and Workflow

This chapter provides details about the data management methodologies the KLMN follows while implementing the data lifecycle. Understanding how data are developed allows us to easily communicate the overall objectives and importance of proper data management throughout each phase of a project. The intent of this chapter is to give a general overview of a project's workflow; more detailed information may be found in other chapters and the appendices of this document.

The KLMN will adhere to the data management methodologies associated with the data management lifecycle. The data management lifecycle is a cyclic six step process for developing and managing data throughout the lifespan of a project that includes planning, implementation, access, evaluation, archiving, and maintenance (Figure 8). Although variation may occur with the duties associated with the six phases of the data management lifecycle, each phase of the lifecycle should be addressed every year a project is implemented. The KLMN will adhere to the data management methodologies associated with the data lifecycle as budget, time, and project goals allow.

While the KLMN will deal with a large variety of data, this chapter discusses data management associated with two main types of projects:

- **Short-term projects**. These projects include a variety of studies that are usually completed between one and five years. Two examples are inventories and pilot projects.
- **Long-term projects**. These are projects that will be designed to last greater than five years. These projects tend to extend beyond current technology, personnel, and data collection methodologies and to collect large volumes of data over time. Consequently, they require a higher level of documentation and data management to ensure that comparable data are collected over the life of the project (Boetsch et al. 2005).

In planning a short or long-term project, it is still necessary to follow the data lifecycle. Each project will produce similar data (Table 6) that will need to be managed and made available to a diversity of users.

The Data Lifecycle

From the time it is decided to collect data until the data become obsolete, those data need to be accounted for and managed. Following the data lifecycle (Figure 8) approach to data management allows personnel to understand the various stages of a project design and how data management plays a role in each stage. It is important that every individual participating in a project funded or sponsored by the KLMN understands the data lifecycle and realize that the information we are collecting will go far beyond the immediate needs of the project.

The information we are collecting will go **far beyond** the immediate needs of the project

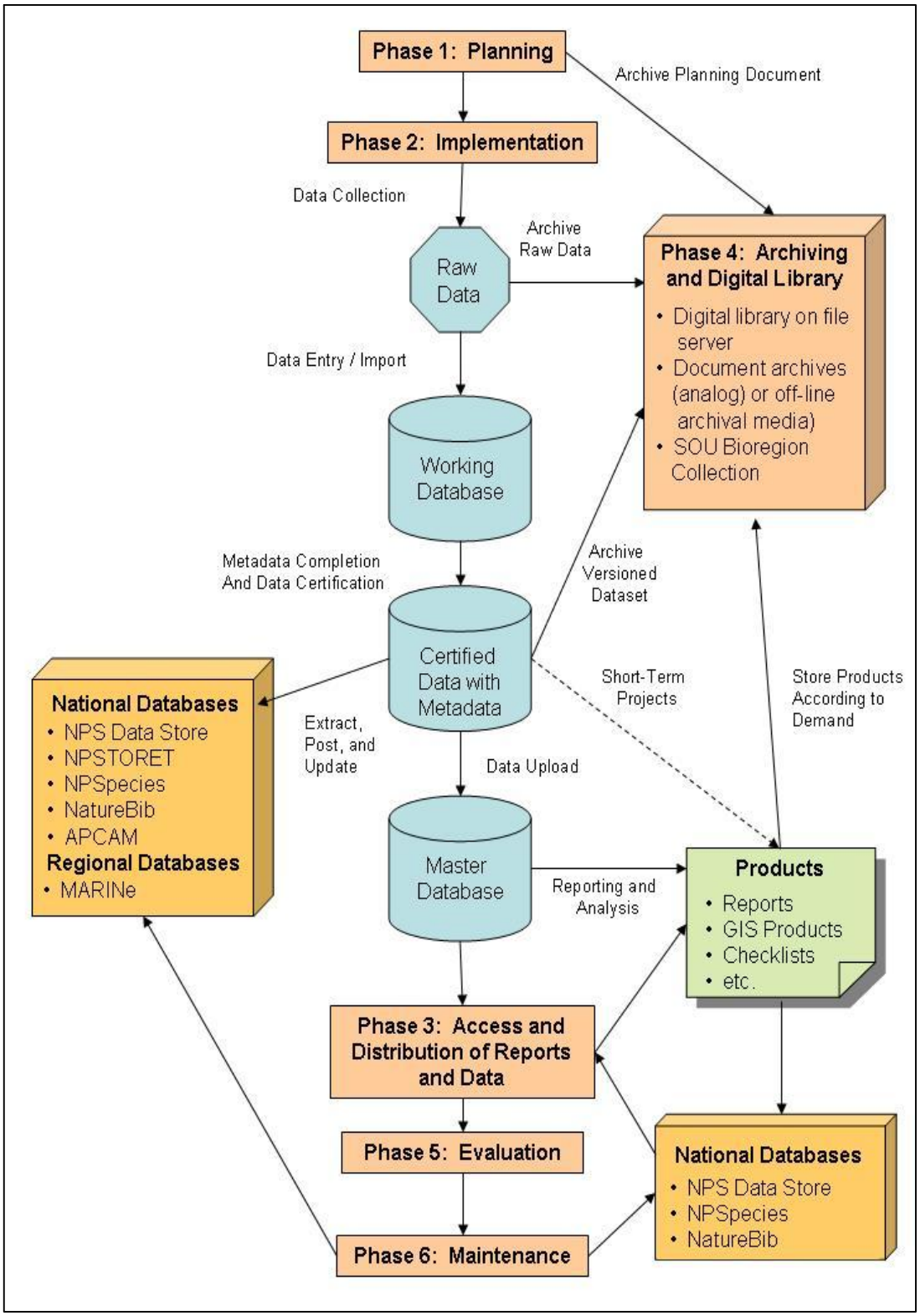

Figure 8. Conceptual model of the cyclic process associated with the data lifecycle of a project.

Table 6. Categories of data that will be managed during an I&M project.

Data Category	Examples
Raw Data	Field forms and notebooks, photographs, digital data (sound/video recordings, GPS data, probe data, data loggers, telemetry data)
Derived Data	Relational databases, GIS layers, maps, analyses
Documents	Protocols, data dictionaries, FGDC / NBII metadata, photograph log
Reports	Progress reports, scientific publications, annual reports
Administrative Records	Contracts, agreements, study plans, permits and applications

Planning

Planning is the first and one of the most important steps in the data lifecycle. The planning phase can be a complex and arduous process. However, spending the time to meticulously plan all aspects of the project will save a considerable amount of time, effort, and money in the other phases of the project. During the planning phase:

- Goals and objectives of the project are determined and clearly stated.
- Ownership of the data and products is determined.
- A project record is created and populated in the project tracking database.
- Inventories of related information are reviewed and rated for usefulness.
- Proposals and budgets are created and funding sources are determined.
- Work plans are created.
- Contracts, agreements, and permits are obtained.
- Protocols, SOPs, and guidelines are selected or developed as needed.
- Attribute entities and rule sets are defined.
- Databases, datasheets, metadata, and data dictionaries are designed.
- Deliverables are identified and due dates are determined.
- Storage and dissemination methods are created.
- Timelines are determined.
- Equipment is purchased.

Implementation

The implementation phase of the project is when the on-the-ground work begins. It is during this phase that we can begin to determine what data management methods are working, what methods need to be adjusted, and what methods need to be reassessed. During the implementation phase:

- Field crews, contractors, and additional personnel are hired and trained.
- Data are collected, entered, undergo QA/QC processes, certified, stored, and secured.
- Data management methods are tested and adjusted as needed.

- Data are converted to information through statistical analysis, GIS analysis and map development, creation of dataset catalogs and metadata, and preparation of reports.

Access

One of the core goals of most KLMN projects is to create information that can be utilized by park staff, the public, and the scientific community, providing them with up-to-date information about natural resources occurring in and around the parks. To do this job efficiently, a methodology must be in place to allow users easy access to tabular and spatial data, reports, and photographs collected during the project. In this phase:

- Products and data are distributed to a diversity of users including park staff, KLMN employees, SOU personnel, national I&M databases, and the scientific community on a predetermined timeline.
- Data are stored in a manner that is secure but allows for timely distribution when needed.
- Information created from the project is posted to or used to update national databases including NPSpecies, NatureBib, NPS Data Store, STORET, ANSC+, and NR-GIS Clearinghouse as needed.
- Klamath Network intranet and internet websites are updated with pertinent information.
- Reports and associated metadata are sent to SOU's Hannon Library for distribution.

Archiving

As stated in the 2006 NPS Management Policies, "*Information about natural resources that is collected and developed will be maintained for as long as it is possible to do so. All forms of information collected through inventorying, monitoring, research, assessment, traditional knowledge, and management actions will be managed to professional NPS archival and library standards.*" The Network will utilize the knowledge and infrastructure provided by SOU and Redwood National and State Parks (RNSP) to meet our archiving and storage needs. Details about the archiving process are included in the *Data Maintenance, Storage, and Archiving* chapter. In order to preserve the data for long-term use, archived data must:

- Be secure and easily accessible to meet future requests (e.g., FOIA, parks staff, and the scientific community).
- Include all documentation needed to understand the archived datasets, images, and GIS information. This includes administrative documents, reports, metadata, and data dictionaries.
- Be stored in its original format and in a comma-delimited, American Standard Code for Information Interchange (ASCII) text file. ASCII files will include the content of each file, relationships that may occur between tables, attribute definitions, and associated documentation.

Evaluation

The technology, methodology, and perspectives used to create and implement a project are dynamic and can change on a regular basis. It is important to constantly review all the aspects of a project to determine what is working, what needs to change, what needs to be added, and most importantly, what can be done better or more efficiently. During this phase:

- Evaluation of the collection methodologies, protocols, SOPs, and guidelines is conducted to determine if they are still valid.
- Periodic evaluation of the data being collected takes place to determine if they are still needed and useful.
- Overall evaluation of the project occurs to determine if the methodologies being used are in a direct relation to the goals and objectives of the project.
- Evaluation of the data management methodologies used to obtain, manage, disseminate, and archive the data transpires to make sure the methodologies are still efficient.

Maintenance

In order to maintain the highest quality useable data, maintenance of the data and the products created from the data (metadata, databases, reports, and the administrative records) is conducted on regular intervals (usually at the end of each field season). During this phase:

- Metadata, data catalogs, and data dictionaries will be evaluated to make sure they are up-to-date and meet all previously outlined standards.
- Seasonal data will be reviewed prior to integration with the master databases to make sure they are complete and meet data quality standards.
- Records in the project database will be updated.
- Data will be screened for sensitive information and protected from unauthorized use.
- Databases and datasheets will be updated to meet current objectives.
- Known users of the information will be informed of any revisions to the data or supporting documents.

Data Acquisition and Processing

This chapter describes the processes and guidelines the KLMN will follow for acquiring or collecting datasets, entering or integrating datasets into a project database, and digitizing datasets for use with a computer. Data are collected using varied equipment and sampling methodologies, stored in different formats and locations, and used for a variety of purposes. Therefore, there is no single data collection protocol that is suitable for all projects within a park. The origin and purpose of the data will dictate the processes and procedures KLMN will use to acquire, verify, and utilize the information. Data managed by the Network fall into three generalized categories:

- **Programmatic data** – Data that was obtained from projects conducted or fully funded by the Klamath I&M Program.
- **Non-programmatic NPS data** – Data that was produced by the NPS but the Klamath Network had no involvement or provided a minimal amount of funding.
- **Non-programmatic external data** – Data that was produced by a source outside the NPS (Sanders 2005).

Regardless of where the data originate, their overall quality and associated documentation are key factors in determining the importance and usefulness of the data for inventorying, monitoring, and managing park resources.

Programmatic Data

Since projects that fall into this category are funded or conducted by the KLMN, we will have the greatest control over the protocols, standards, and methodologies used to obtain and manage the data. The data management methodologies used in a given project will depend on the needs outlined and protocols developed during the planning phase of that project. Some general data management methods the KLMN will follow are listed below.

Data Collection

Data collection is the process of gathering raw data through various methodologies which include amassing current data already available, collecting data in the field, and assembling legacy data to support a project. Some of the various methods the KLMN implements to collect data in an accurate and efficient manner are listed below.

Project and Research Planning: Prior to project implementation, methodologies for data acquisition are clearly stated. Legacy data is examined to determine if there is any useful information available. GIS data is checked for usefulness and obtained along with corresponding metadata. Data dictionaries describing each attribute to be collected are developed and utilized to create databases and field forms for the project. Timelines and templates for deliverables are outlined and documented. If a project is not using a peer-reviewed protocol, then a data management section needs to be included in the study plan.

Ensure that field crews are properly trained: It is the Field Crew Leader's and Project Manager's duty to adequately train field crews in the data collection and management methodologies outlined in the study plan or protocol. Field crews should be effectively trained in equipment use, sampling methods, database and datasheet use, data entry, transcription, backup procedures, and quality control standards. For larger projects where crew turnover is expected, a training manual is recommended. A log should be kept outlining the training sessions each crew member attends, and transferred to the Data Manager at the end of each field season (Appendix C).

Field Sampling: The Data Manager and Project Manager work closely together to determine data management standards for each project. Once field sampling begins, Field Crew Leaders and Project Managers are expected to follow the elements of the Data Management Plan germane to their projects. Such elements are determined in the planning phase of each project. In addition, SOPs and guideline documents (selected or developed in the project's planning phase) will be adhered to with regular checks by the Project Manager and Data Manager to determine if correct procedures are being followed. It is the Project Manager's responsibility to make sure field crews are aware of and follow those standards.

Supervision: Periodic checks of data collection techniques used by the field crews are conducted to make sure they fully grasp and have not strayed from the protocols or study plan. Random checks of the data are conducted by the Project Manager to make sure methodologies are followed and equipment is used properly. The schedule of checks should be based on a schedule determined during the planning phase of a project.

Log Books: It is the responsibility of the Project Manager to transfer all log books to the Data Manager at the end of each field season. A log book is kept to document any major decisions being made or events that have occurred to the protocol, SOPs, or guidelines. Another log is kept documenting the training each member of a project receives. In addition, a log is kept of all equipment being used to collect data and calibration times for that equipment. These log books record the event, date, and time in a manner so it can be used to adjust the databases, methodologies, or standardized reports (Appendix C).

Automated Data Collection Devices: Whenever possible, Project Managers are encouraged to utilize electronic equipment for data collection. This includes, but is not limited to, GPS units, probes, and data loggers. Electronic systems will be backed up by the field crews in a timely manner. Backup times will vary depending on the equipment and methods being used but are determined prior to the start of the field season.

Calibration and maintenance of equipment: It is important to obtain the most accurate data possible while in the field. Field technicians should be familiar with calibration and maintenance requirements of all equipment. Consult the equipment manual for suggested calibration times and methods.

Cameras: Photographs are a valuable tool used for a multitude of objectives including conducting outreach, identifying specimens, displaying habitat conditions, documenting

field work, and analyzing data. It is the responsibility of the field crew and the Project Manager to follow the KLMN Photograph Guidelines available through the KLMN internet or by directly contacting the Network Data Manager. The Project Manager should submit project-related photographs and photograph metadata (Appendix E) to the Data Manager at the end of each project.

Field Computers: Field computers such as personal digital assistants (PDA), palmtop computers, and tablet personal computers (PC) can be used to improve data entry efficiency, data quality, and reduce time constraints. While using field computers, data should be downloaded nightly unless otherwise stated during the planning process. Batteries should be checked, replaced, or charged on a daily basis prior to going into the field. Spare batteries should be kept with the computer while in the field. Hardcopy datasheets should be carried with the computer in case failure of the device occurs while in the field. Benefits and disadvantages of field computers include:

Advantages:

- Improved data accuracy by reducing the number of data transcription errors from field datasheets.
- Possible inclusions of a database with pick lists and domain values to reduce errors.
- Ability to be downloaded directly to a desktop PC, decreasing data entry time.
- No risk of misplacing datasheets.
- Ability to utilize GPS and GIS technology in association with a relational database, improving the accuracy of spatial data.
- Opportunity to bring additional materials to the field, including reference documents, protocols, and identification guides in an electronic format.
- Ability to share, manipulate, and backup data before leaving the field.
- Capability of transferring data directly to the main office via wireless internet prior to leaving the field.

Disadvantages:

- Are affected by environmental constraints such as moisture, heat, and dust.
- Can have limited memory and battery power.
- Can be heavy or fragile; special care needs to be taken while conducting intense field work.
- May require additional programs to create data entry forms and databases.
- Can be difficult to read in the field due to weather and environmental conditions.
- Can risk losing a substantial amount of data if not backed up regularly.
- Can be subject to typographical errors that are difficult to detect.

Field forms: All data should be entered into well-conceived hardcopy or digital field forms to ensure that field data entry is efficient and consistent. Hardcopy or electronic field forms should be designed to the following specifications:

Hardcopy Forms:

- Hardcopy forms mimic the electronic form when applicable.
- Paper and writing devices should be able to withstand the environmental conditions of the project area. Acid-free paper should be used to prevent fading and subsequent loss of data. In addition, "Rite in the Rain" paper should be used to prevent data loss from moisture.
- Datasheets are bound during use to prevent the likelihood that one or more sheets become separated or lost from the rest. Datasheets should be numbered and a log kept that records unused or missing datasheets.

Electronic Forms:

- Electronic forms need to match the hardcopy field forms.
- Electronic forms are kept as simple as possible. Do not include pictures or designs. Keep the forms clear and easy to read.
- Pick lists and auto-populated fields are utilized when possible.
- Domain values are to be set to prevent invalid data.
- Forms include as much pre-printed information as possible.

Remote Sensing and GIS: Remote sensing and GIS are powerful tools that the KLMN use to help provide information for vital signs monitoring and inventories. There is a large variety of data available and consideration needs to be given to the following:

- Project needs
- Accuracy and resolution
- Frequency of measurement
- Cost
- Licensing for public use
- Ortho-rectification needs
- Availability

In addition, there is much variation among the different types of data and imagery. Complete documentation for GIS and remote sensing data will be required prior to dissemination or use in analysis. For GIS data, every attempt will be made to use the most accurate information available. The KLMN currently (as of 8/15/2007) has a task agreement with SOU to jointly locate and develop base cartography for each park. GIS layers will be made available to the parks via the National I&M NPS Data Store. As a mandated requirement, any GIS data posted at the NPS Data Store is be accompanied by FGDC-compliant metadata.

Legacy Data: Data acquisition has occurred in all parks within the KLMN since their establishment within the National Park Service through inventories, monitoring, and scientific research. To capture this information, the KLMN started data mining efforts to catalog the natural resource information held at each park. The cataloging of research and

management projects conducted at each park will help preserve institutional knowledge, contribute to the 12 basic inventories, and allow future studies to build upon past projects.

Data Entry

Data entry consists of entering the data into an electronic format or transferring data from a field collection device to a desktop computer located in a stable environment. Procedures for data entry and download are designed on a project-by-project basis and are dependent on the data collected, the equipment used, and the methodologies applied. Methods will be outlined in the narrative and SOPs for each vital sign monitoring protocol and in the study plan for each inventory the KLMN supports. The Klamath Network uses a variety of methods to make certain data are entered into an electronic format in as accurate and complete a manner as time and budget allow.

In **NO** circumstances should data entry be left until the end of a field season.

Accuracy and Timeliness: As stated in DO#11B, "All information will be accurate, timely, and reflect the most current information available." Data will be entered and QA/QC accomplished in a timely manner. Data entry and backup schedules are determined during the planning phase of a project. When possible, data entry should be conducted on a weekly basis unless determined otherwise. In no circumstances should data entry be left until the end of a field season. It is the responsibility of the field crew to make sure all data collected during the week are entered and documented prior to going into the field the following week unless stated otherwise.

Hardcopy datasheets: Projects need to have standardized datasheets created by the Project Manager and Data Manager. Datasheets will clearly identify the data that need to be collected, incorporate pick lists when appropriate, be designed to mimic the electronic database entry interface when applicable, and include as much preprinted information as possible. At no point in a project should a field notebook be used as a replacement for a datasheet. At the end of the field season, after validation and verification of the hardcopy datasheets, the Project Manager will transfer the datasheets to the Data Manager, where they will be scanned and stored at the KLMN in a PDF format. It is important that data entry forms are easy to use, once complete can be read by most people, and clearly communicate the information to the reader. Data forms should adhere to the following:

- The entire form should be completed at the site and double checked (if possible, by a crew member who did not enter data on the field form) prior to leaving the site.
- All handwriting will be printed and legible. When possible, another crew member should check the datasheet for legibility prior to leaving the site. If another crew member is not available, the Project Manager should check the datasheets on a predetermined schedule to ensure they are legible.
- If a change is made to the field form after leaving the site, a single line will be drawn through the data with the corrections made next to the error (or on an additional sheet if more room is needed) and initialed by the crew member making the correction.

- Immediately upon return from the field, forms should be reviewed by the Project Manager and stored in their designated location.

Databases and Electronic Forms: The KLMN will take advantage of databases already designed for the purpose of a given project when possible (e.g., MARINe, WRD STORET, WIMS). For databases already developed, the KLMN will create a process to incorporate the data into the KLMN master database. The master database will store data for all vital sign projects. If a database has not been developed for a project, we will utilize the KLMN NRD as described in the *Infrastructure and System Architecture* chapter. It will be the responsibility of the Data Manager, in coordination with the Project Manager, to tailor the front-end component of the KLMN NRD database for each project.

If possible, electronic devices should be used to collect field data. The use of handheld devices decreases the need for manual data entry from field forms, which in turn reduces errors related to transcription. When using an electronic databases pick lists, domain values, and specialized formats are used to reduce the potential for data entry errors. When using electronic devices such as GPS units, data loggers, laptops, or PDAs:

- Complete documentation of the hardware and software used to collect the data should be included in the metadata.
- Devices should be downloaded daily unless another schedule has been predetermined during the project's planning phase.
- Batteries should be checked and devices should be adequately charged prior to going into the field. If possible, a spare battery should be carried into the field.
- Routine inspections of devices left in the field (e.g., data loggers) should occur as necessary. Calibrations of field equipment should follow the recommendations in the equipment user manual.
- Field equipment can be fragile and every attempt to make them ruggedized should be made prior to going into the field. Ruggedization may include a waterproof hard carrying case, throwaway screen protectors, and shock and dust resistant hardware, and well sealed electronic devices.
- Data should be backed up to a secure location prior to leaving the site.

Using electronic methods to collect data that includes a database and electronic forms are reliable techniques to reduce data entry errors. When conducting electronic data collection, follow these steps:

- Electronic data entry forms should be similar to the field forms in an attempt to reduce errors.
- Databases and electronic forms will be designed using a pick list, domains, and auto-filled fields to reduce errors associated with manual data entry.
- Data will be entered into a blank database where validation and verification will occur prior to being incorporated into the master database.
- Access restraints will be incorporated to prevent users from making unwarranted changes.
- When possible, users will be prevented from closing out a record if all data has not been entered.

Data Editors: If possible, two crew members should enter the data into the database. One crew member should read the information while the other crew member enters the data. Each crew member should double check the entered record prior to moving on to the next record. Not only will this act as a check for the quality of the data, but it will also speed up the data entry process. Crew members will need to follow data verification procedures outlined during the planning phase of the project and described in the *Quality Assurance and Quality Control* chapter of this document.

Training: It is the responsibility of the Project Manager and Crew Leader to make sure all crew members are trained in proper data management protocols and procedures prior to starting a project. The Project Manager and Crew Leader will assess crew member techniques throughout the project to determine if additional training is needed. It is the responsibility of the Project Manager to transfer completed data to the Data Manager. However, it would be worthwhile to train one of the crew members or the Crew Leader in this process to act as a backup.

Changes to Protocols and Procedures

While the KLMN will make every attempt to use protocols and SOPs that have been peer-reviewed and thoroughly tested, it is anticipated that some protocol alterations will occur over time. It is also expected that many of the changes will occur during the first five years after project implementation. However, over the long-term, adjustments in technology, methodologies, or project goals may require us to make additional modifications to the protocol and/or SOP. The Project Manager will work with the Network Coordinator and Data Manager to determine the best methods for protocol adjustments. If significant changes are needed or intended, the protocol may be reevaluated by the Regional I&M Coordinator for possible peer review. Revisions made to the narrative or SOPs of a protocol should be recorded within the document that was adjusted.

Non-Programmatic NPS Data

The KLMN will utilize data gathered by the NPS at the local, regional, and national level as the need arises. These data can be used for a variety of important processes, including, but not limited to: creating baseline data, monitoring site selection, collecting ancillary data, developing protocols, ground truthing of remotely sensed or derived spatial data, and performing quality control. The Data Manager will work with NPS personnel to determine what data are available and how they can be incorporated into the KLMN projects.

Park Data

In 2004, the KLMN initiated a data mining project to inventory the natural resource information currently stored in the KLMN parks to preserve institutional knowledge, allow future studies to build upon current and past projects, and support I&M monitoring planning. This data mining project is planned to run through FY 2007. The intent of the data mining activities is to document the what, where, when, who and how's of the data. During the first phase of the project, we concentrated our efforts on six taxonomic

groups: amphibians, birds, fish, mammals, reptiles, and vascular plants. Within these groups, we found documentation to support a species list, located documents with species abundance and distribution information, and used the documents to populate the NatureBib bibliography and NPSpecies databases. In Phase II, we expanded our criteria to record references from the other inventory categories and to document datasets using the I&M Access database, Dataset Catalog. If enough information about the dataset was available and the dataset could be incorporated into the KLMN monitoring project, FGDC-compliant metadata were created using NPS Metadata Tools and Editor and the NPS Metadata Database Extractor. Original copies of all information found during the data mining process remain at the parks. A catalog of all the information was entered into NPSpecies, NatureBib, NPS Data Store, and Dataset Catalog, as appropriate (Bridy et al. 2005).

Regional and National Programs

There is an assortment of regional and national programs that will help provide long-term benefits to the KLMN and the parks within the Network. Many of these programs are being used to contribute to the 12 basic inventories outlined by the National I&M Program. It is the goal of the Network to document our work within these programs as time and funding allows. The KLMN will also utilize these programs to provide information, gather and organize data, and transfer information to the Network parks. Some of the programs that provide a good resource for natural resources monitoring information include:

- **Air** – The Air Resources Division, in partnership with parks and others, works to preserve, protect, enhance, and understand air quality and other resources sensitive to air quality in the NPS. The NPS Air Resources Division (ARD) provides spatial and tabular air quality data through their website at: http://www2.nature.nps.gov/air/index.cfm.

- E**xotic Plants –** Exotic Plant Management Teams (EPMTs) collect and maintain data displaying the presence of exotic species within the parks. This information along with treatment information can be found in the Alien Plant Control and Monitoring Database (APCAM) at: http://www.nature.nps.gov/biology/invasivespecies/.

- **National I&M Program** – The KLMN will utilize databases developed by the National I&M Program to disseminate and obtain data related to GIS, parks species, bibliographic information, and metadata.

- **Climate** - The first climate inventory was done by the National I&M Program to compile baseline climate data useful to NPS biologists, hydrologists, and resource managers. The inventory integrated data from more than 6,000 precipitation stations and 4,000 temperature stations across the conterminous United States to develop maps with relevant climate variables. The inventory produced both GIS-based and tabular products; these are now available for most NPS units. Data in

the climate atlas can be downloaded from the original Natural Resource FTP site at: http://science.nature.nps.gov/nrftp.

- **Geology** - The NPS Geologic Resources Evaluation (GRE) Program is a cooperative endeavor to implement a systematic, comprehensive inventory of the geologic resources in NPS units. Geology information is available though the NPS Data Store web page at: http://science.nature.nps.gov/nrdata/.

- **Water –** The National Hydrography Dataset (NHD) is the NPS standard for spatial hydrography data. The NPS Water Resource Division (WRD) provides assistance with water quality data management by maintaining the NPSTORET database to transfer NPS data to the WRD database. The database is found at: http://www.nature.nps.gov/water/waterquality/index.cfm.

- **Soils –** Soils information is provided by the Natural Resource Conservation Service (NRCS) and maps for the completed parks can be found at http://science.nature.nps.gov/im/inventory/soils/index.cfm.

Non-Programmatic External Data

In the information age we live in, there is a wealth of information available from a diversity of individuals, agencies, counties, universities, and private organizations. Since the vast amount of information would overwhelm the programs modest storage capabilities, the Network will access information for specific needs as they arise. When utilizing external data, the KLMN will require that complete documentation of any dataset is obtained prior to using the data for project design, analysis, or publications.

While adhering to data management practices required by the NPS, the KLMN will attempt to utilize data management methods that are compatible with non-NPS inventory and monitoring efforts in the region. Within the Pacific West Region, there are several databases (e.g., WIMS, MARINe) that are utilized by various agencies and organizations to collect and analyze data at the regional level.

Data Processing

It is important to process information obtained from external sources so it can be integrated with other data managed by the Network. The degree to which the data can be used will be proportional to the accuracy and completeness of the metadata. The Data Manager will work with the Project Manager and GIS Specialist to determine the value of a dataset and to convert the acquired data into a format that is compatible with data managed by the Network. Generally, data obtained from non-Network sources and used in project development, data analysis, or dissemination will be managed in the following manner:

- GIS data managed by the Network will be converted to a Universal Transverse Mercator (UTM) projection with a NAD 83 Zone 10 datum.

- Park-related biological and physical data and citations will be entered into the National I&M databases.
- Reference material will be stored in the KLMN electronic library.
- Hardcopy forms and notebooks will be stored in locked field cabinets and transferred to an electronic format (PDF) when possible.
- Datasets should be converted into the KLMN NRD format if possible.
- Data will be subject to the *Data Naming* and *File Storage* guidelines.

Quality Assurances and Quality Control

One of the most important aspects of data management is ensuring that data (and metadata) are of known quality. The level of quality will vary and may depend on purpose, budget, available equipment, and personnel. Understanding the level of accuracy of a given dataset will allow the user certain levels of confidence when applying the data to management purposes. In order to detect a change in natural resource trends or patterns over time, the acquired data needs to be of high quality with minimal error or bias. Data of inadequate quality can lead to loss of sensitivity which may result in misinterpretation of the information.

While it is always the goal of the Klamath Network to obtain 100% accurate data, this is a nearly impossible task. Errors inevitably occur from a range of sources and must be anticipated, minimized, and corrected where possible. The Network will apply well-conceived and proven QA/QC methods to ensure that data are held to the highest possible standard of accuracy and precision.

Quality assurance is the planned and systematic pattern of all actions necessary to provide adequate confidence that the project optimally fulfills expectations (i.e., that it is problem-free and able to perform the task for which it was designed). Quality control should be independent of the collection procedures and is the process of examining the data after it is produced to make sure it is in compliant with data quality standards.

Data Quality and the National Park Service

In 2001, Congress directed the Office of Management and Budget (OMB) to issue federal government-wide policy and procedure guidelines to ensure and maximize the quality, objectivity, utility, and integrity of information disseminated by the federal government (Public Law 106-554; HR 5658). The following definitions apply:

- **Quality** – An encompassing term including objectivity, utility, and integrity.
- **Objectivity** – Whether disseminated information is being presented in an accurate, clear, complete, and unbiased manner. In addition, objectivity focuses on ensuring information is accurate, reliable, and unbiased.
- **Utility –** Refers to the usefulness of the information for its intended users, including the public.
- **Integrity –** Refers to the security of the information, insuring the information is protected from unauthorized users.

In 2002, OMB implemented these guidelines through a notice to the Federal Register and in return the NPS issued Director's Order (DO) #11B to comply with these requirements. Beyond meeting the guidelines initiated by the OMB, DO #11B discusses information standards related to reliable data, accuracy of data, and timeliness of the data. It continues to state that these standards will not only be applied to data collected by the NPS, but also to any non-NPS information the NPS relies upon for analysis, dissemination, or decision making.

Goals and Objectives for Quality Assurances

Careful consideration should be given when determining the quality of the data as defined in DO #11B needed to meet project goals and objectives set forth during the planning phase of a project. The level of data quality required will depend on the project, the selection of standard operating procedures, and the sampling methods. It will be the responsibility of individuals participating in the project to ensure QA/QC processes are followed.

Roles and Responsibilities

Each individual working on an inventory or monitoring project will have some responsibility towards data management. In most cases, the QA/QC procedures outlined in the planning phase of a project are the responsibility of the Network Data Manager, GIS Specialist, Project Manager, Crew Leader, and the field crew. Specific roles and responsibilities include:

Data Manager:

- Creates policies, guidelines, and SOPs to ensure data quality.
- Designs, implements, supports, and manages database systems for long-term monitoring projects, inventory projects, and various other I&M activities. Makes sure databases support quality data through quality assurance protocols.
- Provides training and technical assistance to field staff on data QA/QC, protocols, and methodology.
- Evaluates data collected prior to incorporation into a master database or dissemination to other users.
- Ensures all documentation accompanies data as collection occurs.
- Makes sure each person working on a project understands his/her roles and his/her responsibilities towards data management while in those roles.

GIS Specialist:

- Develops procedures for field collection of spatial and GPS data and techniques.
- Documents data in compliance with FGDC / NBII metadata standards.
- Establishes and implements procedures to protect sensitive spatial data according to project needs.
- Provides training and technical assistance to field staff on QA/QC, protocols, and methodology.
- Provides efficient access to spatial information via the web, national I&M databases, and direct contact.

Project Manager:

- Works with the Data Manager and GIS Specialist to develop, document, and implement SOPs for field data collection, entry, QA/QC procedures, metadata documentation, and data transference.
- Supervises and certifies all field operations including training for data collection and equipment use, data management, and personnel management.
- Documents all field activities that relate to data management.

- Works with the Data Manager and Network Coordinator to determine workload priorities, timelines, summaries, final reports, and deadlines.
- Serves as point of contact (POC) for all issues related to data collection.

Crew Leader:

- Works with the Project Manager to train field crews in data collection, QA/QC methods, and equipment use and maintenance.
- Verifies and validates all data following methods established during the planning phase of a project prior to transferring the data to the Project Manager.
- Completes logs for training, method change, and datasheet documentation.
- Works with field crews to collect and transfer data.
- Stays aware of and follows established protocols and procedures for data collection and management.

Crew Members:

- Collect data and complete verification and validation methods.
- Under the guidance of the Crew Leader, stay aware of and follow established protocols and procedures for data collection and management.
- Work closely with the Crew Leader and Project Manager to detect data quality issues.
- Study and master methods to operate and maintain field collection equipment, including instrument calibration, data entry, error checking, data download, and data transfer.

Methods for Reducing Errors in a Project

A majority of the errors associated with data occur during the data collection and data entry phase of a project. There are several methods and techniques the KLMN requires project related staff to follow to help reduce the opportunity for errors. It is important to note that not all of the following methods can be applied to every project. The Data Manager and Project Manager will coordinate and determine which methods are best suited for the project.

Data Collection

Data collection is the process of gathering raw data through various methodologies which may include amassing current data already available, collecting data in the field, and assembling legacy data to support a project. In the *Data Acquisition and Processing* chapter of this document, the KLMN has outlined several QA/QC processes that we are implementing. The details for these tasks are documented in the monitoring protocols and inventory study plans for each project the KLMN implements or funds.

Data Entry

Data entry consists of entering the data into an electronic format or transferring data from a field collection device to a desktop computer located in a stable environment. Procedures for the quality control and assessment processes associated with data entry and download are designed on a project-by-project basis and are dependent on the data

collected, the equipment used, and the methodologies applied. Methods will be outlined in the protocols for each vital sign monitoring project and in the study plan for each inventory project the KLMN supports. Some general QA/QC methods the KLMN utilizes to make certain date entered into an electronic format are accurate are listed in the *Data Acquisition and Processing* chapter of this document.

Data Verification

Data verification is the process of ensuring the data entered into a database mimic the data recorded on the hardcopy field forms and data loggers. Details on verification procedures will be outlined on a project-by-project basis by the Data Manager and Project Manager. In general, there are four methods that can be used to conduct proper data verification.

1) **Visual review at data entry**. This method should always be used when entering data. In this method, the technician verifies each record after input. Records entered into the databases are compared to the data on the hardcopy datasheets and errors are corrected immediately.
2) **Visual review after data entry.** After the data have been entered, all records are printed out and compared to the original values. Printed forms should be in the same format as the datasheets and database form. Errors need to be marked on the form and then corrected in the database (Southwest Alaska Network 2006).
3) **Duplicate data entry** – Data entry is done as normal. However, a predetermined random number of records are entered into the database and into a blank database. A database query is then used to compare the records and report any mismatches. This method is more time consuming, but it gives an accuracy measurement of the data entry (Sanders 2005).
4) **Review** – After following the processes outlined in #1-3 above, it is the Project Manager's responsibility to review a predetermined subset of records that have been entered into the database and compare them to the original hardcopy forms. A timeline should be developed during the project's planning phase to outline the number of records that will be checked and a time frame as to when they will be examined (Southwest Alaska Network 2006).

Data Validation

While data verification can be completed by someone with little to no knowledge of the data, data validation requires a reviewer to have extensive knowledge on what the data mean and how they were collected. Data validation is the process of reviewing the finalized data to make sure the information presented is logical and accurate. The accuracy of the validation process can vary greatly and is dependent on the reviewer's knowledge, time, and attention to detail. General data validation procedures include:

1) **Data entry application programming**. When possible, filters for illegal data will be used to prevent data being entered that exceeds its logical value (e.g., 20 m vs. 2000 m tree height). It is important to note that not all fields have appropriate

domains and it will be the responsibility of the Project Leader to examine these fields for erroneous data.

2) **Outlier detection and review**. An outlier is an unusually extreme value for a variable, given the statistical model being used to analyze the data. It is important to note that not all outliers are a result of data contamination; they may be indicators of important thresholds or extremes in variation of the parameter of interest. Statistical tests such as Grubbs' test, regression mapping, and graphical displays such as scatter plots will be used to examine the data for outliers (Michener 2000). Depending on the analysis methodology, outliers may not need to be removed. A determination will need to be made to define what is considered an "unusually extreme" value indicating data contamination or an environmental aberration that clouds the interpretation of the field measurement. Generally, non-error-associated outliers should be flagged and retained, allowing those conducting data analysis to make determinations about inclusion or rejection.
3) **Review of what makes sense.** The Crew Leader and the Project Manager should be intimately familiar with the types of data being collected, including expected data ranges. The individuals in these roles should review the tabular data to make sure it appears logical. GIS data should be plotted and examined to determine the accuracy of the spatial locations (Sanders 2005).

Data Quality Review

As the KLMN continues to develop our Data Management Program, it will be important to constantly review and update our data management procedures. During any project managed or funded by the KLMN, we will:

- Work with the Project Manager and Crew Leader to examine current QA/QC procedures and, if needed, update or change those procedures. A log will be kept to record any major or minor revisions to the data management procedures of a project.
- Conduct random spot checks of KLMN projects to make sure they are conforming to all standards and protocols. If problems occur, the Data Manager will report those problems in writing to the Project Manager and Network Coordinator. It is the responsibility of the Project Manager and Network Coordinator to correct the problems.
- Collect evaluation forms on a seasonal basis from field crews to determine the need for improvement in data management or training associated with data management. To confirm processes are clear and useful, the Data Manager will work with the Project Manager and field crews to make sure everyone is comfortable with all data management processes. Evaluation forms are developed on a project-by-project basis.

Quality control and assessment procedures, along with a statement assessing the overall quality of the data, will be included in the metadata for each project. Additional documentation procedures are outlined in the *Data Documentation* chapter.

Version Control

Versioning is the process of documenting the temporal integrity of files as they are being altered. Long-term projects tend to outlive current staff, technology, and in some cases, the methodologies that were originally developed for the project. As one updates the documents, spatial files, and databases that were developed for a project, it is important to be able to trace the changes of those products over time. More importantly, because the products are changing, the editor must have a way to communicate to the project staff which product is the most up-to-date. Through versioning, an individual can quickly determine which product he or she should be utilizing to perform monitoring or inventory work.

Version Control Methods

There are several different methods that can be employed to represent the version of a document, GIS layer, spreadsheet, or database. Some of these include:

- **Dates** – Adding a date to the name of a file acts as a logical version control method. When using dates, they should be in the format: YYYYMMDD. This enables the user to sort several version of a document when the creation dates spans multiple years.
- **Sequential Numbering** – Adding a version number such as v1.0 or 001 can be used to keep track of the document's various versions. Care needs to be taken to ensure that everyone actively engaged in a project is aware of the most current version. In addition, a date should be included in the document to let the reader know when a version was changed.
- **Including "Final"** – It can become difficult for a user to determine what the final version of a product is when there are multiple versions available. Including the word "Final" in the title is an easy way to declare a version as the most up-to-date. In a rare instance, a document that is considered final may need to be updated. Care needs to be taken to remove the word "Final" from the name of the older document and add it to the revised copy.
- **Version Control Software** – Version control software such as Workshare Professional and Data Pump can be used track and synchronize multiple versions. These software applications track changes made to the document, add comments related to those changes, and can easily retrieve each version of the document.

Unless stated otherwise, the KLMN will include a date and a version number (for easy readability) in the name of each file when version tracking is required. The date will be in the format YYYYMMDD and the version number will be in the format vX.Y where "X" is adjusted for each major revision and "Y" is increase for each minor revision.

Unless stated otherwise, the KLMN will include a date and a version number in the name of each file.

Data Documentation

Quality data can be rendered nearly useless for long-term needs if they are not documented in a manner that lets future users understand their content, purpose, and limitations. A humbling but exciting reality is that long-term monitoring projects should be designed to outlive most of the personnel currently working on the project. Consequently, metadata are essential for future users and interpreters of the data. This is particularly true for those elements describing data quality and use, which form the basis of making informed decisions regarding the fitness of a particular data source (Chrisman 1994). The metadata, at the very least, should reference locations of key information about a project, usually found in project tracking databases, protocols, reports, and field notes. As stated in Director's Order #19, *"The National Park Service also has a strong business need for excellent records management, since the mission of the NPS is to care for natural and cultural resources so that they are 'unimpaired' for future generations. This requirement for managing resources in perpetuity sets a high standard for record keeping, as no resources can be managed well into the future without complete records of how they were managed in the past."*

Mandates for Documentation

The NPS GIS committee requires all GIS data layers to be described with FGDC standards and the NPS Metadata Profile. Executive Order 12906 directs the FGDC to coordinate the federal government's development of the National Spatial Data Infrastructure (NSDI). It calls for agencies to use the FGDC Content Standard for Digital Geospatial metadata (CSDGM) to:

- Contribute to a national geospatial data clearinghouse and use the clearinghouse to determine data availability prior to starting a new data collection project.
- Document datasets according to metadata standards and support public access to data.
- Cooperatively develop data content standards and other geospatial data standards as deemed necessary.

The FGDC *Biological Data Profile* contains all the elements of the CSDGM and incorporates additional elements for characterizing biological datasets. In addition, metadata conforming to the Biological Data Profile can be incorporated into the National Biological Information Infrastructure (NBII) clearinghouse.

The NPS *Metadata Profile* (http://science.nature.nps.gov/nrdata/docs/npsprofile.cfm) extends the original seven sections of the CSDGM with information specific to the NPS. The NPS GIS Committee requires all new spatial data be described according to FGDC standards and the NPS Metadata Profile. The NPS Metadata Profile is also utilized by the NPS Data Store for managing GIS and other data for both internal and external use.

Roles and Responsibilities for Data Documentation

A summary of the roles and responsibilities for documentation are listed below. Proper documentation will help preserve the intuitional knowledge about the project, ensure the data are used in an appropriate manner, and help guarantee the accuracy of the data over the life of the project. In addition, documentation of project activities will allow the KLMN to monitor changes to the project over time.

Crew Leader

- Documents requests for training, support tools, and protocol issues.
- Collects data and populates field forms and/or databases.
- Completes data management log books.
- Prepares written documentation of changes to the project protocols or methodologies.
- Completes the data management survey prior to completing project duties.

Project Manager

- Works with the Data Manager to document data collection protocols and procedures.
- Provides datasheet, photograph, training, and project log books to field crews and the Data Manager (when complete).
- Develops metadata including, but not limited to, data dictionaries, QA/QC procedures, metadata interview forms, and data collection protocols.
- Develops progress and summary reports, publications, and annual reports.

Program Assistant

- Works with the Data Manager, Project Manager, and Network Coordinator to keep the project records in the project database current.
- Incorporates all photographs and associated metadata into the KLMN Photograph Database.
- Ensures that documentation for databases, maps, and project information accompanies any information posted on the KLMN internet and/or intranet websites.

Data Manager

- Provides support to staff in metadata development.
- Works with the Project Manager to document protocols and SOPs.
- Checks metadata to make sure it is FGDC and NBII compliant.
- Documents all aspects of database development and use.
- Monitors KLMN staff to ensure documentation is occurring in a timely manner and reports issues to the Network Coordinator.
- Works with the Network Coordinator, Program Assistant, and Project Manager to update and complete the records in the project management database.

Documentation Process

The overall goals of metadata creation are to develop a comprehensive document that 1) explains enough about the project data to ensure they are useable for future personnel and the scientific community, and 2) complies with FGDC and NPS mandates for federal projects. Metadata development begins at the start of every project; as the project develops, so do the metadata (Figure 9). Within the sideboards set by the program and federal requirements, the process of metadata creation will vary depending on goals and objectives, funding, and scope of the project. It is the responsibility of the Data Manager to set forth the metadata requirements and the process used to create the metadata. Listed below are some of the general methods of metadata documentation the KLMN intends to follow for all I&M projects.

Planning Phase

Most of the metadata creation begins in the planning phase of a project. During this phase, the Data Manager works with the Project Manager to outline the time frames and methodologies for metadata creation. In general, multiple documents and databases will be used to create the metadata for all projects, including the project tracking database, project annual reports, protocols, certification forms, and metadata interview forms.

Project Tracking Database: It is the duty of the Program Assistant to work with the Data Manager, Project Manager, and Network Coordinator to create and update the records in the Project Tracking Database for each project. The project tracking database is used to record:

- Project name, tracking numbers, and project classification type
- Start date, target completion date, contacts, and associated parks
- Funding and permits
- Abstract, activities, and accomplishments
- Deliverables and projected dates
- General notes

Project Database, Datasets, and Forms: The Project Manager will work with the Network Data Manager and GIS Specialist to develop data dictionaries for all tabular and spatial datasets. The data dictionaries will be in a standard format and each attribute will include: 1) table name, 2) field name, 3) field type, 4) field size, 5) domain ranges, 6) is the field required, and 7) a short description of the data in the field (Appendix D). The data dictionaries will be used by the Data Manager to help develop the database and database metadata. The metadata will include a description of all reports or forms that are incorporated into the database, a list of tables and queries with descriptions, and a list of all relevant QA/QC processes applied. Once data have been certified by the Project Manager (usually at the end of the field season); he or she will work with the Data Manager to complete or update the metadata.

Legacy Data: Data documentation is an old concept that has been gaining more recognition in recent years. Due to staff turnover, inconsistent funding, a preference for data collection, and reluctance to allocate adequate funding and effort to data

management, results from past efforts in parks are not readily available to guide I&M efforts. Although there is a wealth of knowledge from past efforts in the KLMN parks, documentation of legacy data was often incomplete, making it nearly impossible to create FGDC-compliant metadata for historic projects. Nonetheless, the KLMN will make every attempt to integrate legacy information into projects to help save time, provide high quality information, and prevent the "reinvention of the wheel." The degree of usefulness of legacy data for the Network will be directly correlated with the desired purpose, availability, and documentation of the data.

Wherever possible, the KLMN will convert existing metadata for any legacy datasets utilized by the Network into an FGDC acceptable format. If full metadata cannot be completed, metadata will still be developed and populated as completely as possible. While there are several uses for poorly documented or undocumented datasets in the development of a project, it is important to recognize that careful consideration of all information should be measured prior to being used in analysis or being disseminated to the public.

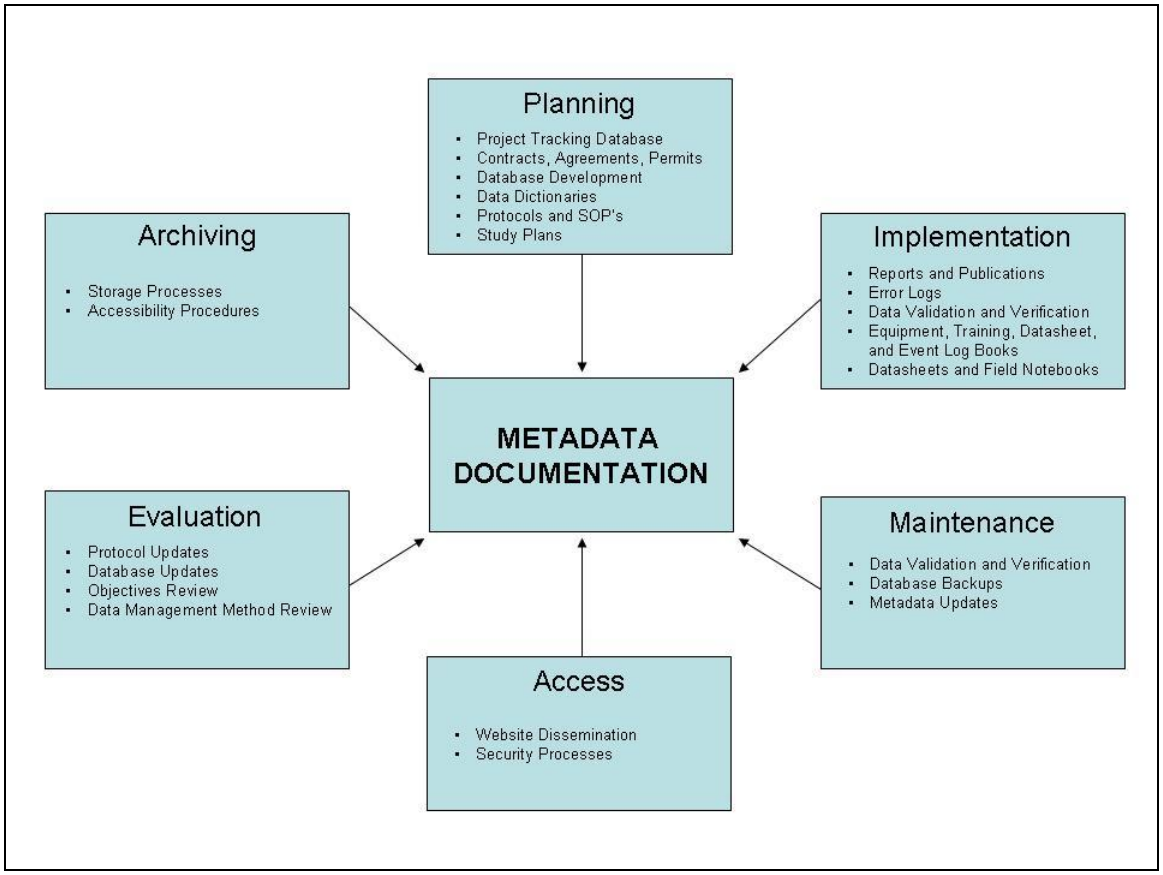

Figure 9. Metadata documentation throughout the various phases of the data lifecycle.

Implementation Phase

During the implementation phase, it is important to document any changes that may occur to the sampling protocol, data management methods, personnel changes, training,

or equipment. During this phase, field crews and the crew leaders should be initiating the validation and verification procedures outlined during the project's planning process.

Log Books: During the implementation phase, the Project Manager is responsible for keeping logs of datasheets, special events, equipment, and training. Standard log forms can be obtained from the Data Manager (Appendix C). Details about these logs are included in the *Data Acquisition and Processing* chapter. These logs should be turned in with the data at the end of the field season, when applicable. The Data Manager will use the logs to update the project metadata.

Data Validation and Verification: It is the responsibility of the Project Manager and Data Manager to include data verification and validation procedures in the metadata. The Project Manager should include in the metadata the methods utilized to: enter data into the database, check the data after entry, and analyze the data to search for anomalies that may need to be removed. When developing databases, as discussed in the *Quality Assurances and Quality Control* chapter, the Data Manager must make every effort to include validation measures in the database. These measures need to be recorded and incorporated into the metadata for each project.

Metadata Interview Form: The KLMN utilizes a metadata interview form that describes the various attributes of a dataset (Appendix A). The interview form includes information about the time frame, description, sensitivity, collection location, and purpose of the data, plus various other pieces of information needed to develop the metadata for the dataset. It is the Project Manager's responsibility to complete a new metadata interview form before the start of the first field season and at the end of each additional field season.

Certification Form: The Klamath Network utilizes a certification form (Appendix B) submitted by the Project Manager to ensure:

- The data are complete for the period of time indicated on the form.
- The data have undergone the quality assurance checks indicated in the protocol or study plan.
- Metadata for all data have been provided (when applicable).
- Project timelines are being followed and all products from the field season have been submitted.
- The level of sensitivity associated with the deliverable is appropriate.

A new certification form should be submitted each time a product is submitted. If multiple products are submitted at the same time, then only one certification form is needed for those products.

Access Phase

The KLMN utilizes our internet and intranet websites, SOU, and the National I&M databases to disseminate information to the general community. Prior to dissemination, all spatial information must be associated with FGDC-compliant metadata as described in the *Data Documentation* chapter. Documents should be in the proper format as described in the *Data Analysis and Reporting* chapter. When applicable, metadata should be

completed for all documents prior to distribution. It is the responsibility of the Data Manager to work with the Project Manager and park staff to determine the sensitivity of the data prior to posting. Constraints will be placed on sensitive data to prevent or limit distribution to the public.

Archive Phase

It is the responsibility of the Data Manager to make sure all products archived or transferred to backup storage areas are complete and have associated metadata. The KLMN will rely on SOU for all our backup and archiving processes as described in the *Data Maintenance, Storage, and Archiving* chapter.

Maintenance Phase

Not only is it vital to the KLMN Data Management Program that complete and accurate metadata are developed for each project, but it is just as important that the metadata are kept up-to-date as the project develops. During the maintenance phase, all documents need to be reviewed, brought up to date, and exported to standardized formats.

Database Backup: Prior to the transfer of metadata (and data) to the Data Manager, it is the responsibility of the Project Manager to make sure metadata are being stored with the project data during backup procedures. Upon transfer, this responsibility is turned over to the Data Manager. The Project Manager must keep the Data Manager informed of any changes to the metadata once this transfer has occurred. Once the Data Manager has the data and metadata, he or she is required to follow the backup processes described in the *Data Maintenance, Storage, and Archiving* chapter.

Storage: Once the metadata are complete, they will be transferred to the Data Manager, where they will be saved and parsed into varying levels of information (Table 7). The Data Manager will store the metadata in a project folder located on the KLMN server. Once on the KLMN server, the data will be transferred to the NPS Data Store. From the Data Store, they will be copied to the NPSFocus metadata clearinghouse, where they can be accessed by internet users (Figure 10).

Metadata Parsing: The KLMN will conform to FGDC guidelines and parse metadata into three levels of detail directed towards a variety of users (Table 7). All parsed metadata will be stored as an Extensible Markup Language (XML) and viewable or printable through the KLMN website.

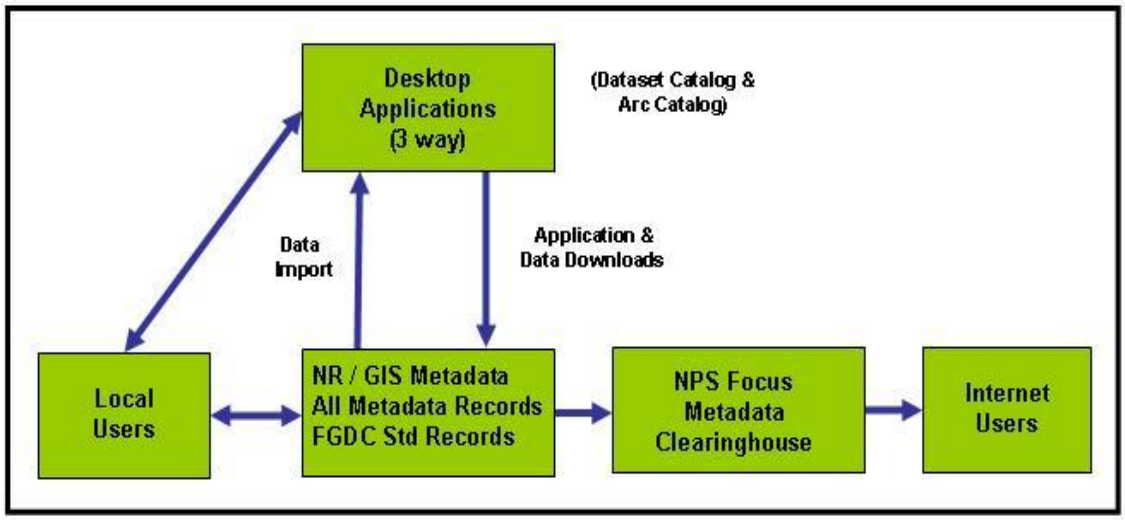

Figure 10. Process to create, store, and distribute metadata at the national level.

Table 7. Metadata parsing strategy.

Metadata Parsing	Purpose
Level 1 – "Manager Level"	Provides an Overview of the Data
Level 2 – "Scientist Level"	Provides an overview of the data AND includes additional details about the quality and usability of the product.
Level 3 – "Full Metadata"	Full documentation which will allow the user to completely understand the product.

Metadata Development

FGDC Content Standard for Digital Geospatial Metadata

The Klamath Network will ensure spatial data posted on the NPS Data Store meet FGDC and NPS standards. The CSDGM consists of seven sections (Sections 1-7), and the NPS Metadata Profile adds another section (Section 0). The Biological Profile is added as elements to Sections 1-7. A summary of the sections is provided below (Svancara and Dicus 2006).

Section 0, NPS Information: Documents metadata purpose, park unit, and data steward.

Section 1, Identification Information: Includes who produced the data, when and why it was produced, and where it is from. Constraints on access and use (e.g., sensitive data) are also recorded in this section. For biological data, this section also includes the geographic extent, bounding altitudes, taxonomy, and analytical tools used.

Section 2, Data Quality: Documents the accuracy of attributes and geographic positions and the procedures used to ascertain accuracy. This section also documents the completeness and lineage of the data. Lineage includes data sources and processing steps and for biological data, the methodology used to derive the data.

Section 3, Spatial Data Organization: Includes methods of spatial reference. Mandatory for spatial data and generally created automatically.

Section 4, Spatial Reference Information: Documents coordinate system definitions. Mandatory for spatial data and generally created automatically.

Section 5, Entity and Attribute Information: Includes attribute names, definitions, codes, and their meanings and other information essential to a basic understanding of the data.

Section 6, Distribution Information: Describes the methods and contacts used for obtaining the data. Also documents information critical for using biological data formatted in ASCII.

Section 7, Metadata Reference Information: Includes who created the metadata, when they were written, the profile used, and the frequency of their update.

Metadata Requirements

Metadata *fully compliant* with FGDC and NPS standards have entries in Section 0 and all element fields in Sections 1-7 considered "mandatory" or "mandatory if applicable." A mandatory element is one which must be populated for all data. A mandatory if applicable element is one which must be populated if the data exhibit the characteristic being documented by the metadata element. For example, the element defining the vertical coordinate system would be mandatory if the data contain elevation values (Svancara and Dicus 2006).

Metadata *minimally compliant* with FGDC and NPS standards have entries in Section 0 and all "mandatory" and "mandatory if applicable" element fields in Sections 1, 6, 7, and Section 2 for biological data. These include the fields used by the NPS Data Store. Data documented to this extent can be distributed via the Data Store's online upload utility (Svancara and Dicus 2006).

Different types of data and information require different kinds and levels of documentation. Standards for documentation of KLMN data are described below.

Spatial Data: Include, at a minimum, all of Section 0 and the required elements of Sections 1-7.

Non-Spatial Data: Include, at a minimum, all elements of Section 0, the required elements of Sections 1, 6, 7, and Section 2 for biological data. The minimum requirements for non-spatial data therefore meet the requirements for minimum compliance with FGDC and NPS standards.

Relational Databases: Document according to the Non-Spatial Data standards above.

Legacy Data: Documented to the extent possible according to the standards outlined above. Metadata that accompany legacy spatial and non-spatial data are suitable for upload to the NPS Data Store if they include entries sufficient for minimum compliance with FGDC and NPS standards. Priority for documentation will be:

- Data needed for current project development.
- Data used frequently by park staff.
- Historic data archived for possible future use.

Metadata Tools

There are various tools the KLMN utilizes to develop metadata that are FGDC-compliant and include the information in the Biological Profile. Some of these tools are:

Dataset Catalog: This database is a tool for keeping an inventory of and providing abbreviated metadata ("metadata lite") about a variety of natural resource datasets, from physical files and photographs to digital scientific and spatial data. Although this tool is no longer supported by the National I&M staff, historically the KLMN has used this tool to document legacy data. The federal government requires that spatial data have fully FGDC-compliant metadata, but for non-spatial data, the Dataset Catalog provides a means for parks to keep an inventory of various data files, notebooks of field data forms, photographs, etc.

NPS Data Store: The NPS Data Store application manages and shares natural resource and GIS metadata and data generated by the natural resource and service-wide GIS programs of the NPS. It was previously named the "Natural Resource and GIS Metadata and Data Store." To facilitate data dissemination to the public and throughout the NPS, the NPS Data Store application posts information to the NPS GIS Clearinghouse located in NPSFocus. The NPS Data Store is part of the NPS Metadata System and provides two functions: the NR-GIS Metadata Database and the NR-GIS Data Server. The NR-GIS Metadata Database is a repository of and search engine for metadata describing natural resource and GIS data. The NR-GIS Data Server hosts natural resource and GIS data (documented by the metadata in the NR-GIS Metadata Database) for download.

NPS Metadata Tools and Editor: The NPS Metadata Tools and Editor is a metadata management and editing application that implements two separate interfaces: either (1) as an extension within ArcCatalog versions 8.3/ 9.x, or (2) as a stand alone desktop interface. The application is intended to be the primary editor for metadata that will be uploaded to the NPS Data Store. The NPS Metadata Tools and Editor application integrates with the NPS Data Store information system by producing XML metadata files based on the NPS Metadata Profile that can then be uploaded to the NPS Data Store application. Metadata editing is done with editing style sheets that transform a standard XML metadata file into an editable record. The initial editing functions include those elements required for upload to the NPS Data Store and Biological Profile metadata elements.

NPS Database Metadata Extractor: This tool was developed by the Natural Resource GIS Program as a Microsoft Access Add-in. The Metadata Extractor is a utility that enables the user to automatically harvest entity (table) and attribute (field) metadata from Access databases (including domains), allows the user to edit and review the harvested metadata and make batch edits, and gives the user the opportunity to export metadata to a FGDC-compliant XML file

USGS Metadata Parser: The Metadata Parser (MetaParser) is a command-line tool that tests metadata files against the FGDC Content Standard for Geospatial Metadata. MetaParser can be configured for other metadata profiles, including the ESRI Profile and the NBII Biological Profile.

Non-Programmatic Data Documentation

Any data used in analysis or distributed by the KLMN will adhere to the same level of documentation as required for KLMN-collected data. It will be the responsibility of the Project Manager to collect metadata from the original entity for all data, prior to conducting analysis. Contracts and task agreements will need to stipulate that all data collected through them also include the submission of full metadata in a format determined prior to signing the agreement or contract. The Data Manager will provide tools and methodologies to help program leaders develop and manage metadata.

Derived Data Documentation

It is inevitable that analysis of long-term monitoring data will produce derived data from datasets that have to be accurately documented. It is the responsibility of the individual creating the derived data to develop compliant metadata if the data are going to be made available to other individuals. In addition to the metadata that generally parallel project data, derived data must include a data lineage that points back to the original dataset.

Data Analysis and Reporting

Raw data are a valuable resource, but until they have been analyzed and transformed into information, they are of limited use. As stated in the I&M NPS-75 document, one of the overall I&M goals is to "*integrate natural resource inventory and monitoring information into National Park Service planning, management, and decision making.*" To do this, the data must be converted into a format that is useable by a diverse number of individuals.

While the overall objective of the KLMN is to create information to be used by the Superintendents, Resource Chiefs, and GIS Specialists of each park, it is recognized that a large number of additional groups, including planners, project managers, resource specialists, interpreters, public, and the scientific community, will come to rely on the information we provide. To convey our information to these other groups, the KLMN will communicate our objectives and accomplishments through annual reports, technical reports, scientific publications, outreach brochures, and displays.

In this chapter, we discuss the methods by which data will be analyzed and converted into information. We will also discuss the various reports that will be used to present the information to the intended users.

Data Analysis

During the analysis phase of a project, the "raw data" are transformed into information that can be used to help understand park natural resource conditions within the Klamath Network. The overall goals of each project will vary, but in general, analysis will focus on three activities: 1) determining status and trends in the condition of the resources being monitored, 2) determining the correlations among resources and known stressors and exploring for abnormal conditions or impairments to those resources, and 3) measuring progress towards performance goals.

There are a nearly infinite number of analysis methodologies that can be undertaken with long-term natural resources datasets. Most of these fall into the following categories:

- Data reduction
- Data transformation
- Graphical analysis
- Time series analyses
- Univariate statistical analysis including conventional, descriptive, and nonparametric statistics
- Multivariate statistical analysis
- Spatial and temporal analysis

It will be the responsibility of the Project Manager, working in conjunction with the Network Coordinator and Statistician/Biometrician, to determine what combination of analysis methodologies is best suited for each dataset. The Data Manager will work with

Network personnel to design or adapt data and database components to support the format necessary for analysis using GIS (e.g., Geodatabases) or statistical (e.g., SYSTAT, R, SPSS, PCORD) software.

Any derived data used to create products distributed to members outside the Klamath Network must be fully documented following the standards described in the previous chapter.

GIS Product Development

It is the responsibility of the field crew and ultimately the Project Manager to make sure spatial data are collected, updated, and accurately documented. It will be up to the Project Manager and GIS Specialist to work together to determine the desired GIS products for each project.

The KLMN is currently (8/15/2007) developing a guideline for the proper use of GPS tools when collecting field data. This will be a detailed document describing the methods to be used when collecting GPS data utilizing the GPS units (various Garmin, Trimble, and integrated GPS / Tablet PC units) provided by the Klamath Network. It is the responsibility of the Project Manager to train the field crews on the correct methods to employ when collecting GPS data.

Metadata for each product will be completed and updated prior to the start of a new field season. Metadata will be created by the Data Manager, working with the Project Manager and GIS Specialist and utilizing the methods listed in the *Documentation Process* chapter of this document. It is important to note that derived spatial data intended for analysis or dissemination must have associated metadata. In addition to standard metadata documentation, derived data must also include the name of the source data.

The Data Manager will work with the GIS Specialist to manage non-spatial project data in a method that it can be incorporated into GIS for spatial and statistical analysis when applicable.

Data Validation

Outlier detection, summary statistics, and exploratory analysis are three methodologies described in the *Quality Assurance and Quality Control* chapter that will be utilized for QA/QC processes in the project's analysis phase. It will be the responsibility of the Project Manager and Statistician/Biometrician to report to the Data Manager any validation issues discovered with the data. It will be the Data Manager's responsibility to work with the Project Manager to make sure the data have been correctly validated prior to entry into the master database.

Reports

Reports are the key mechanism the KLMN will use to keep all interested parties informed of recent findings, accomplishments, and general progress on each project. Network programmatic reports will be used to regularly demonstrate the overall progress and future direction of the Network. Project annual reports will be used to show the annual accomplishments of vital sign and inventory projects. Analysis and Synthesis reports will be developed for each vital sign monitoring project to report information on status and trend, power analysis, recommendations, and correlations between resource characteristics. Comprehensive synthesis reports will be created on a 5-10 year interval and will be used to integrate results from all monitoring projects within and across all parks and disciplines in order to interpret changes to park resources. A one page synopsis of the annual and analysis and synthesis reports will be created for distribution to a large diverse audience. The synopsis will include links to the larger reports. Reports will be made available through the KLMN intranet and internet websites, NatureBib, SOU's Bioregional Collections, and will be emailed to the parks when completed.

Project Summary Report

The Project Manager will work with the Data Manager to develop an automated summary report for each monitoring or inventory project. The summary report will be used to help update the annual report, progress report, and network websites. The project database will be designed in a manner that allows any user to run the summary report at any given point in time. At the end of each active field season, once the data have been integrated into the master database, the Data Manager will run and archive an official summary report.

Project Annual Reports

It is the responsibility of the Project Manager to provide a progress report that summarizes the annual accomplishments, the future direction of a project, and changes to the sampling design or methods. Progress reports are only necessary when there has been some change with a project's progress. For example, if a vital sign is only sampled once every five years, then a progress report is only required once every five years for that vital sign.

Project Analysis and Synthesis Reports

The project analysis and synthesis reports are used to summarize monitoring project data over multiple years. These reports will be developed every 2-10 years and will vary greatly among projects. The role of analysis and synthesis reports is to 1) determine patterns/trends in condition of resources being monitored; 2) discover new characteristics of resources and correlations among resources being monitored; 3) analyze data to determine amount of change that can be detected by this type and level of sampling; 4) provide context and interpret data for the park within a multi-park, regional, or national context; and 5) recommend changes to management of resources (feedback for adaptive management).

Synopsis Report

While it is the hope that all park staff will read all project reports in their entirety, it is recognized that busy work schedules often prevent individuals from reading long reports. In order to educate the park staff on the progress and findings of a project funded by the Klamath Network, one page synopsis reports will be developed to accompany the longer project annual reports and project analysis and synthesis reports. These reports are developed using a standard format and provide some general information about the project including objectives, current or annual progress, key findings, and a link to the larger report. This report will be distributed to all park staff with the goal that upon reading the one page report, interested personnel will be able to make time to read the complete report.

Comprehensive Synthesis Reports

These reports can provide critical insights into resource status and trends, which can then be used to inform resource management efforts and regional resource analyses. This type of analysis integrates data from multiple vital sign monitoring projects and requires several seasons of sampling data. It is important that results from all monitoring projects within and across the six parks be integrated across disciplines in order to interpret changes to park resources. This will be accomplished with a network synthesis report produced at no more than 10-year intervals. Just as with project analysis and synthesis reports, the role of network analysis and synthesis reports is to 1) determine patterns/trends in condition of resources being monitored; 2) discover new characteristics of resources and correlations among resources being monitored; 3) analyze data to determine amount of change that can be detected by this type and level of sampling; 4) provide context and interpret data for the park within a multi-park, regional or national context; and 5) recommend changes to management of resources (feedback for adaptive management).

Annual Administrative Report and Work Plan

Each year, the KLMN creates an annual report summarizing the accomplishments and future direction of the Network. This report includes short summaries of each active project the Network is supporting, budget information, personnel structure, protocol development, available documents, GIS information, and the status of the vital signs monitoring. Annual reports are developed by network staff with the support of the Board of Directors and the Technical Advisory Committee.

Program and Protocol Reviews

The KLMN has spent the last several years developing a system to monitor key resources within the national park units located in southern Oregon and northern California. To ensure the program is running as efficiently as possible we are planning program reviews to occur every 5 years. In addition to the program reviews, we will also conduct reviews for each protocol on a 5 year interval to ensure protocols are meeting the goals and objectives outlined by the KLMN and the parks. Reports will be developed by the Project Managers and Network Contacts and peer reviewed by the Board of Directors, Technical Advisory Committee, and the Regional Coordinator.

Scientific Journal Articles and Book Chapters

This aspect of the program will be directed by the Program Managers and is more at their discretion than the previously described reports. Publishing scientific journal articles and book chapters is primarily conducted to communicate advances in knowledge and is a very important, widely acknowledged means of quality assurance and quality control, via the academic peer-review process. Scientific journal articles and book chapters produced by Klamath Network efforts are tracked by the Klamath Network monitoring program; new publications are listed as part of the Annual Administrative Report and Work Plan, which is sent to the regional and national offices each year. Additionally, all scientific journal articles and book chapters will be entered into the NatureBib database.

Interpretation and Outreach

Scientific information gained from monitoring programs usually requires a concerted effort to be translated for the general public. Through the interpretive programs, the outreach partnership with SOU, the Crater Lake Science and Learning Center, park Natural History Associations, and the Klamath Network's own outreach vehicles, the I&M Program will work to disseminate its findings each year. Occasional, theme-based symposia will be organized by network staff to invite Principal Investigators working in the parks to present their monitoring results and discuss their implications. In the future, the Network plans to produce brochures and fact sheets regarding monitoring and its implications.

Report Format

Project-related reports and the analysis and synthesis reports will be published in the NPS Natural Resource Publication Series. Documentation of the NPS publication standards are available at: http://www.nature.nps.gov/publications/NRPM/index.cfm. Reports will be developed using the NPS Natural Resource Publications template, a pre-formatted Microsoft Word template document based on current NPS formatting standards.

Network annual reports, scientific journal articles, book chapters, and interpretive and outreach materials should be developed in the format designated by the authority where the material will be published.

Data Dissemination

One of the overall objectives put forth to the I&M Program was to provide inventory and monitoring data and information in such a way that they can be integrated into NPS planning, management, and decision making. In order to accomplish this goal, the KLMN will strive to make sure data managed by this program are easily accessible, have been completely documented, and are secure.

Ownership

When working with multiple agencies, cooperators, and other organizations to collect and disseminate information, it is important to define the aspects of ownership prior to implementing a project. Deciding who the owner(s) of the data will be allows the project planners to determine where the information will be stored and duties will be placed, such as who will backup and archive the data, who will have the overall responsibility of maintaining the data, and how will scholarly publication goals be accommodated. The KLMN relies heavily on partnerships, cooperative agreements, and contracts, to collect information about natural resources. It is important that the owners of the data manage them in a way that is complete and accessible to all participants. It is important to recognize that:

- All data and materials collected or generated using NPS personnel and funds become the property of the NPS.
- All research should be submitted for publication in a timely manner. In addition, authorship and formal acknowledgement should accurately portray those individuals and organizations who contributed to the project.
- The parties responsible for collecting, managing, and analyzing the data will be given a reasonable amount of time to publish key finding before the data is made available to the public.
- Personnel must share information, data, and supporting materials whenever relevant. Two of several exceptions to this are sensitive information and personnel data.

Distribution and Mechanisms

Some of the distribution mechanisms the KLMN employ to disseminate information to the parks, scientific community, and public are listed below.

Klamath I&M Network

The KLMN will rely heavily on our websites, national databases, Southern Oregon University, and personal communication to distribute information to the park staff and general public.

KLMN Websites: The KLMN intranet and internet websites will allow direct assess to maps, reports, publications, and raw data. In addition, the KLMN will post draft documents and preliminary data and/or analysis, when applicable, on the intranet website.

Prior to posting any documents, pictures, or data, all material will be screened for sensitive information.

Direct Contact: The KLMN staff will make every attempt to be readily available to parks' staff, the scientific community, and various other potential users of the data managed by the Network. Individuals requesting data should contact the Network Data Manager by email or phone. The requester should send the following information:

- Name and position.
- Contact information.
- Date requested and date needed.
- Request including data needed, transfer method, format, and geographic extent.
- Intent of use statement.

National I&M Program

There are several databases managed at the national level that the KLMN will utilize to provide information to park staff, the scientific community, and the public. Some of these are:

NatureBib: NatureBib is the master web-based database for scientific citations presented as bibliographic references. NatureBib merges a number of previously separate databases dealing with natural resource related topics like air, wildlife, geology, and paleontology. In addition, citations from individually maintained databases like NPSpecies and the Water Resource bibliography are imported to facilitate searching. NatureBib is one of the 12 Natural Resource Challenge inventories (bibliography) and complies with the Government Performance and Results Act (GRPA) goals. The site is designed to facilitate communication among researchers and make natural resource information more readily available and easy to locate.

NPSpecies: NPSpecies is the NPS database to store, manage, and disseminate scientific information on the biodiversity of all organisms in NPS units. NPSpecies was developed to meet one of the 12 core natural resource inventories funded by the NPS I&M Program. Currently, species lists for six taxon groups have been certified for each park in the KLMN. These are mammals, reptiles, amphibians, vascular plants, birds, and fish.

NPS Data Store: The NPS Data Store (previously known as the Natural Resource and GIS Metadata and Data Store application) manages and shares natural resource and GIS metadata and data generated by the NPS. To facilitate data dissemination to the public and throughout the NPS, the NPS Data Store application posts information to the NPS GIS Clearinghouse located in NPSFocus. The NPS Data Store is part of the NPS Metadata System and provides two functions: the NR-GIS Metadata Database and the NR-GIS Data Server. The NR-GIS Metadata Database is a repository of and search engine for metadata describing natural resource and GIS data. The NR-GIS Data Server hosts natural resource and GIS data for download.

IRMA: The Natural Resource Program Center (NRPC) is in the process of transitioning data systems to a Service Oriented Architecture (SOA) and XML web services development approach for data management and delivery. The project called Integrated Resource Management Applications (IRMA) will initially integrate three NRPC data systems: NatureBib, NPS Data Store, and NPSpecies into a common web portal. Eventually, integration of these data systems with other NRPC applications is planned.

Other NPS Programs

NPStoret: The water quality component of the Natural Resource Challenge (NRC) requires that vital signs networks archive all physical, chemical, and biological water quality data collected with NRC water quality funds in the NPS Water Resources Division's (WRD) STORET database. To facilitate archiving data in the STORET database, the WRD has been developing a series of Access-based templates (called NPSTORET), patterned after the NRDT, for networks to use to enter their water quality data in a STORET-compatible format. Vital signs networks will send their data from NPSTORET or their own data systems (in the proper format) to the WRD on an annual basis for quality assurance and upload into the WRD's copy of STORET and the Environmental Protection Agency's (EPA) STORET National Data Warehouse (Figure 9.1).

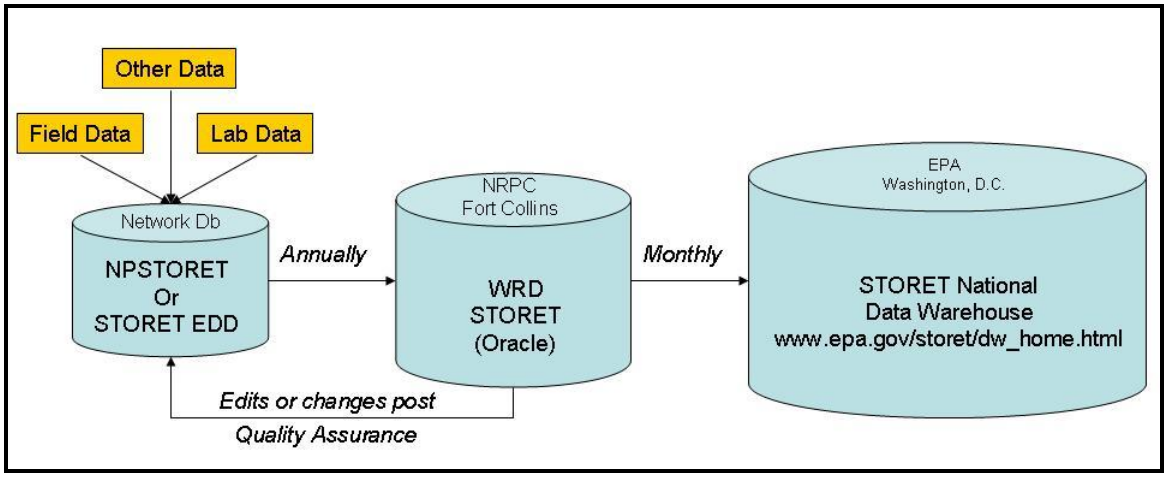

Figure 11. Simplified conceptual model of the Natural Resource Challenge vital signs water quality data flow from collection to distribution.

Non-NPS Locations

SODA: Southern Oregon University has developed the Southern Oregon Digital Archives (SODA), funded by a grant from the Institute of Museum and Library Services. They have developed a digital library primarily from the SOU Library's rich collections of federal, state, and county publications. The library is concentrating its efforts on two collections of regional materials pertaining to the Southern Oregon Bioregion and the First Nations/Tribal Collection. The SODA Project was started in July 2001; public access to the SODA database began in October 2002. The KLMN is in the process of incorporating our reports into the Bioregion collection component of SODA to help contribute to a broad array of information from this region.

MARINe: As part of the KLMN Intertidal Monitoring Project, we are incorporating our data into a database developed as part of the MARINe partnership. The MARINe partnership of local, State, and Federal agencies, universities, and private organizations monitors rocky intertidal sites along the coast of California, including the islands, on a long-term basis. It represents the largest program of its kind on the west coast. Many of the sites have been monitored consistently for 15-20 years. A standardized set of Core Protocols are used to monitor rocky intertidal habitat each fall and spring at 80 MARINe sites in California and Oregon. These data are funded by multiple partners and are entered into a common database for analysis. Sites are spaced every 10 to 15 miles along the coast on the mainland and offshore islands. Continuous monitoring provides resource managers with early warnings of abnormal conditions, such as the discovery of the withering foot syndrome which has affected black abalone across the coast. In addition, the Biodiversity Protocol is used to map and derive a complete species list at 91 sites from Alaska to Mexico. This data collection is funded by a MARINe partner, PISCO, the Partnership for Interdisciplinary Study of Coastal Oceans.

Sensitive Data and the Freedom of Information Act

The KLMN recognizes the need to protect sensitive data from being released to unauthorized personnel. We will make every attempt to work with the Project Manager and park staff to define sensitive information for all datasets managed by the Network. In addition, the Network will follow any stipulations provided in the Freedom of Information Act (FOIA).

Sensitive Data

Data and information managed or funded by the KLMN will be screened for sensitive information prior to release. The level of access that needs to be applied to a particular dataset or document will be determined by the Network Data Manager and Project Manager, in conjunction with park personnel.

Freedom of Information Act

The Freedom of Information Act (FOIA; 5 U.S.C. 552), originally enacted in 1966, is a broad disclosure law, intended to allow public access to government records. FOIA requires federal agencies, including the NPS, to share information with requesting parties unless that information is covered by one of following nine exceptions.

- Specifically authorized under criteria established by an Executive order to (A) be kept secret in the interest of national defense or foreign policy and (B) are in fact properly classified pursuant to such Executive order;
- Related solely to the internal personnel rules and practices of an agency;
- Specifically exempted from disclosure by statute (other than section 552b of this title), provided that such statute (A) requires that the matters be withheld from the public in such a manner as to leave no discretion on the issue, or (B) establishes particular criteria for withholding or refers to particular types of matters to be withheld;

- Trade secrets and commercial or financial information obtained from a person and privileged or confidential;
- Inter-agency or intra-agency memorandums or letters which would not be available by law to a party other than an agency in litigation with the agency;
- Personnel and medical files and similar files the disclosure of which would constitute a clearly unwarranted invasion of personal privacy;
- Records or information compiled for law enforcement purposes, but only to the extent that the production of such law enforcement records or information (a) could reasonably be expected to interfere with enforcement proceedings, (b) would deprive a person of a right to a fair trial or an impartial adjudication, (c) could reasonably be expected to constitute an unwarranted invasion of personal privacy, (d) could reasonably be expected to disclose the identity of a confidential source, including a state, local, or foreign agency or authority or any private institution which furnished information on a confidential basis, and, in the case of a record or information compiled by a criminal law enforcement authority in the course of a criminal investigation or by an agency conducting a lawful national security intelligence investigation, information furnished by a confidential source, (e) would disclose techniques and procedures for law enforcement investigations or prosecutions, or would disclose guidelines for law enforcement investigations or prosecutions if such disclosure could reasonably be expected to risk circumvention of the law, or (f) could reasonably be expected to endanger the life or physical safety of any individual;
- Contained in or related to examination, operating, or condition reports prepared by, on behalf of, or for the use of an agency responsible for the regulation or supervision of financial institutions; or
- Geological and geophysical information and data, including maps, concerning wells.

In 1996, the Electronic Freedom of Information Act Amendment, or "EFOIA," updated FOIA to put more emphasis on proactive information delivery. FOIA establishes specific requirements for federal agencies to make information available electronically, particularly information that is of public interest. Under EFOIA, bureaus/offices were required to make certain “reading room” records created on or after November 1, 1996, available electronically by November 1, 1997. This requirement applies to records covered under section 552(a)(2) of the FOIA, including: final opinions rendered in the adjudication of cases; policy statements and interpretations adopted by the department that are not published in the Federal Register; administrative manuals and instructions affecting the public; and frequently requested FOIA documents.

Other Policies

The NPS is directed to protect information about the nature of location of sensitive resources under the following:

- Executive Order No. 13007, Indian Sacred Sites, instructs agencies to accommodate access to and ceremonial use of Indian sacred sites on federal land by Indian religious practitioners, avoid adversely affecting the physical integrity

of such sacred sites, and maintain the confidentiality of those sacred sites, where appropriate.

- National Parks Omnibus Management Act (NPOMA; 16 U.S.C. 5937) is interpreted to prohibit the release, under FOIA, of information regarding the nature and specific location of certain cultural and natural resources in the NPS.
- National Historic Preservation Act (16 U.S.C. 470w-3), prohibits the release of information about the location, character, or ownership of certain historic resources under certain circumstances. This law also identifies conditions under which the Secretary may release this information.
- Federal Cave Resources Protection Act, 16 U.S.C. 4304, prohibits making information concerning the specific location of any significant cave available under FOIA except under certain circumstances.
- Archaeological Resource Protection Act, 16 U.S.C. 470hh, prohibits the release, under FOIA or any other law, of information concerning the nature and location of certain archeological resources. This law also identifies conditions under which the Secretary may release this information.

Feedback

The KLMN will attempt to make sure information developed from the program has a wide distribution; we will be happy to accept additional comments on potential distribution location and tools. Request should be submitted to the Network Data Manager by email or phone and include:

- Requester's name and position
- Contact information
- Date
- Request details

Data Maintenance, Storage, and Archiving

This chapter discusses the procedures the KLMN will follow to maintain, store, and archive digital and physical products managed by the Network. Physical products include, but are not limited to, hardcopy reports, aquatic samples, non-digital photographs, specimens, hardcopy datasheets, and emails. Digital products include, but are not limited to, databases, spreadsheets, raw data, digital images, electronic documents, and spatial data.

Digital Data Maintenance

The infrastructure the Klamath Network will utilize to maintain the data managed by the Network is presented in the *Infrastructure and System Architecture* chapter of this document. The Network recognizes computer hardware and software can change at a rapid pace and data storage methodologies must be kept in line with the current technology. Data can easily become inaccessible to users if the data are stored using out-of-date software, unsupported hardware, or outmoded media. As software and hardware evolve, datasets must be maintained and migrated to new platforms so they continue to be accessible. To keep data accessible, the KLMN will standardize products required by the Department of Interior agencies. In addition, the Network will archive digital datasets in a format that is independent of a specific platform or software. In general, the data the KLMN will maintain can be divided into short-term datasets and long-term datasets and their related components.

Short-Term Datasets

Short-term datasets are expected to complete the data lifecycle within a five year time period. At the end of the project, the Data Manager will make certain the project folder contains all necessary information including data, metadata, reports, publications, photographs, and the administrative documentation. As the KLMN changes versions of software, datasets will be migrated as needed to ensure accessibility to the end-users. No dataset will be stored in a software package more than two versions behind the current software version used by the KLMN.

At least one copy of all tables contained in a dataset will be stored in a comma-delimited, American Standard Code for Information Interchange (ASCII text file. The files will be accompanied with a text file that explains:

- Content of each file
- Relationships that may occur between tables
- Attribute definitions
- Associated documentation

Short-term datasets with associated documents and metadata will be maintained on the KLMN working directory in the file structure shown in the *Infrastructure and System Architecture* chapter of this document.

Long-Term Datasets

Long-term datasets will be divided into subsets of data based on the field season. Data gathered during a field season will be treated in a similar manner as a short-term dataset. Once the data have undergone QA/QC and documentation processes by the Project Manger, they will be transferred to the Data Manager, who will merge the data into the project folder and associated programs. It is the Data Manager's duty to merge the seasonal datasets into the master database, maintain version control procedures for all documents and data, update the metadata, and store the data in the working and archive directories. Active long-term datasets will conform to the current NPS and I&M version standards.

Quality Assurances for Converted Data

ASCII files created for storage purposes will undergo a quality assurance process to ensure all data within a dataset have been correctly converted. Record counts and attribute structure will be examined to determine if data have been correctly processed. It is the Data Manager's responsibility to properly covert, document, and store the ASCII files. It will be the Project Manager's task to examine the data for completeness and to determine if the information has been thoroughly documented.

Spatial Data

It is the responsibility of the Project Manager to work with the GIS Specialist to complete FGDC-compliant metadata for all GIS and GPS data created for a project. On a predetermined schedule, spatial layers and metadata will be transferred to the Data Manager for storage. It is the duty of the Data Manager to work with the Project Manager and GIS Specialist to maintain and update all GIS data.

Spatial data managed by the KLMN will be maintained and stored on databases servers utilizing ArcSDE and Oracle Database Enterprise. The server will consist of 13 drives with various RAID (redundant array of independent disk) configurations. The server infrastructure will be maintained by SOU while the data will be managed by the Network Data Manager in conjunction with the GIS Specialist. In addition, copies of spatial layers created from project data will be included in the GIS subfolder of the corresponding project folder. As with short and long-term tabular datasets, no spatial data will be stored in a software package more than two versions behind the current software version used by the KLMN.

Digital Still Images

Images obtained to support a project should be collected in a Joint Photographic Experts Group (JPEG) format, if possible. The resolution and settings should be applied in a manner that produces an image of printable quality while still maintaining a reasonable file size.

We recognize that field crews may take numerous pictures that are not directly associated with the current project. Therefore, it is the responsibility of the Project Manager to submit only project-related photographs and associated image metadata to the Data Manager. Submitted photographs should adhere to SOPs developed during the project's

planning phase. In conjunction with the photographs, metadata needs to be included that follows the KLMN Photographs guidelines (Appendix E). It is the Data Manager's responsibility to store and archive photographs following KLMN processes and procedures. The KLMN has developed a guideline document for all photographs submitted to the Network that support KLMN projects. The guidelines outline the process for collecting digital photographs, metadata that needs to accompany the photographs, and procedures and databases used for photograph storage.

Physical Data

Physical data includes photographs, specimens, DVDs, CDs, datasheets, and notebooks. Ownership of the data, information, and products produced from a project will be clearly stated during the project's planning phase. For products being managed by the KLMN, we will work closely with park curators to determine the preservation process and location on a project-by-project basis. The KLMN will provide park curators with the necessary information to accurately catalog products. These data will be saved in a comma-delimited format (.csv) for automated uploading into ANCS+.

Specimens

Specimen archive locations will vary depending on the project and park. The Project Manager will work closely with park staff and NPS curators to determine the best location to store biological, aquatic, and botanical specimens. At no point will specimens be stored at the Network office unless proper storage facilities are provided.

Photographs

When applicable, the KLMN will follow the general guidelines in Conserve O Gram numbers 14/1 to 14/9 for photograph preservation. Some general guidelines in these documents include:

- Methods to mount photographs
- Storage enclosures for photographs and negatives
- General care and maintenance procedures for color and monochrome photographs

Datasheets

Hardcopy datasheets will be converted to an electronic copy (PDF) prior to storage. Datasheets will be stored in a locked file cabinet that is clean, dark, and dry. PDF documents will include the name of the project, Project Manager's last name, and the year of the field work in the title. File folders' naming convention should include:

- Project name
- Site name (if applicable)
- Year the data was collected

DVD and CD

The KLMN will follow the guidelines provided by Fred Byers in the NIST Special Publication 500-252 document entitled "Information Technology: Care and handling of

CDs and DVDs – A Guide for Librarians and Archivists." Some of the general methods in this document include:

- Use a non-solvent-based permanent marker to mark the label side of the disk.
- Store disk upright in a clearly marked case.
- Return disk to storage case immediately after use.
- Store the disk in a cool, dry, dark environment.
- Use CD/DVD cleaning detergent, isopropyl alcohol, or methanol to remove dirt or materials.
- Do not touch the surface, bend the disk, or use adhesive labels.
- Do not expose disk to heat, humidity, or extreme temperature change.

Backup Processes

Proper storage of data needs to take into account the risk of data loss from a variety of natural and man-made causes including, but not limited to, fire, flood, user error, hardware and software corruption, vandalism, and security breach. The KLMN, in cooperation with SOU, will backup data on a nightly, weekly, and quarterly basis. Nightly backups are done by SOU to store information that has been edited. This is not a full backup but is intended to protect products that have been manipulated. This information is stored for a one week period before it is recycled.

SOU begins a weekly full backup of their servers on every Friday and stores the files on tape drives. The entire backup takes 25-30 hours to run, which includes all the SOU and KLMN data. Backups are stored for 60 days before the tapes are reused.

SOU runs quarterly backups on March 31st, June 30th, October 31st, and December 31st of each year. Files stored on a quarterly basis are maintained for one year before being recycled.

Backups are originally stored in a Scalar I500 tape library. Once backups are complete, the tapes are moved to a fire-safe room where they are stored for one week prior to being moved to a locking fire safe. The tapes are stored in the fire safe for an additional week and then moved off-site to a storage system maintained by Records Masters of Southern Oregon. After one year (quarterly backups) or two months (weekly backups), those tapes are returned to the University for recycling. It is the responsibility of each employee to store all materials on the Network (G:), GIS (GIS 1), or personal workspace (F:). Any material not stored in these locations will not be subject to SOU backup processes and may be lost.

Archiving and Storage

A data archive is a collection of data and documentation, stored in a manner that it can be easily located, accessed, understood, and used. The archived data should be secure from natural and man-made disasters. In addition, the data and associated documents need to be stored and updated into a format that is accessible in an age of fast-paced technological change (Michener and Brunt 2000).

It is the responsibility of all KLMN employees, and ultimately the Network Data Manager, to make sure data are stored in a manner that is complete and easy to retrieve and archive. The KLMN stores electronic data managed by the Network on a server that is maintained by SOU. Hardcopy documents and books are stored in a variety of locations at the Network office including open cabinets, personnel desks, and locking file cabinets. It is the responsibility of each employee to keep their file cabinets clean and well organized. At a minimum, hardcopy files should be cleaned up and reorganized every five years. Any hardcopy documents that are considered valuable to the Network activities should be scanned, archived electronically, and hardcopies stored in locking file cabinets.

Prior to permanently leaving the KLMN, employees are expected to inventory and cleanup any data or documentation they have contributed to while working for the Network. Upon providing the KLMN with a two week notice, the employee should stop working on their current projects and spend the two week period documenting his/her data, cleaning up their computers, organizing any materials on the Network drive for which he or she is responsible, and sorting through documents in their file cabinets. It is the Data Manager's responsibility to work with the employee on the cleanup and archiving processes.

Data and Network Security

Access to KLMN-managed data is controlled by SOU using Novell Network and by setting up a KLMN "group" that defines various level of data access. It is the responsibility of the Data Manager to work with SOU IT personnel to manage the number of users. Currently (8/15/2007), four SOU administrators and 11 personnel (KLMN/SOU) have access to the data. Physical access to servers and storage tapes is limited to selected SOU IT personnel and is monitored by passwords and key cards. Backup tapes are transported in water-proof Pelican cases that are locked prior to leaving the storage safe.

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APPENDIX A. METADATA INTERVIEW FORM

[Note: Please make your responses directly within this word document in "Red" type.]

1. Have you already prepared metadata for this dataset?

    a. If yes, please send a copy of the document or reference to where it can be found and skip to item 18.

2. What is the title of the dataset?

3. Who are the originator(s)/owner of the dataset? (Include address, and telephone number)

    a. If someone else should answer questions about the data, please list the name, address, and telephone number.

    b. Are there other organizations or individuals who should get credit for support, funding, or data collection and analysis?

4. Does the dataset contain any sensitive information that should not be released to the public? NPS?

    a. Explain why the data should not be released to the public.

    b. Explain why the data should not be released to NPS staff outside the park.

5. Is the dataset published or part of a larger publication?
    a. If so, what is the reference?

6. Include a brief (no more that a few sentences) description of the dataset.

7. Why were the data collected in the first place?

8. What is the time period represented by the dataset?

9. Were the data developed primarily through:

    a. Field visits?
    b. Remote instrumentation (e.g., temperature recorders, etc)?
    c. Existing data sources?

Appendix A. Metadata interview form (continued)

10. What is the status of the data you are documenting? – *complete, in progress, planned*

    a. Will the dataset be updated? If so, how frequently?

11. Where were the data collected? Include description and coordinates, if known.

12. List some keywords to help search for this dataset.

    a. Thematic, Place, Temporal, Strata, Taxonomy

    b. If a controlled vocabulary was used, what is the reference?

13. List any related datasets that could be documented for cross-reference.

14. The FGDC Biological Profile includes the means to document tabular datasets, taxonomy, field methods, and the use of analytical tools or models.

    a. Was your dataset developed using a model or other analytical tool?

        i. If so, what is the reference

        ii. If the model or tool is available, include a contact and/or URL.

    b. Does the dataset contain biological information? If no, skip to item 15.

        i. What species or communities were examined?

        ii. Did you use a taxonomic authority or field guide for identification? If so, what is the reference?

        iii. Briefly summarize your field methods. (Cut and paste from other documents!)

            1. If you used existing protocols or methods, list the references.

        iv. If you use a different taxonomic hierarchy than what is available in ITIS, then you need to supply the taxonomic hierarchy for all species within the dataset.

15. Is your dataset archived in a databank or data catalog? If yes, please include a reference to the documentation and skip to item 16. If No:

Appendix A. Metadata interview form (continued)

a. What measures did you take to make certain that your dataset was as nearly correct as possible?

b. Were there any things that you excluded from your data collection (e.g., stems less than a certain diameter or streams without surface flow)?

c. What is the form of your dataset? *spreadsheet, ASCII file, GIS layer, database, other*

d. What is the filename for your dataset?

   i. For each file or table, list the fields in the dataset. For each field, list:

   ii. The definition of the field.

   iii. If the data are coded (Enumerated Domain), the codes and the definitions.

   iv. If the codes come from a published code set (Codeset Domain), the reference.

   v. If the data are measured (Range Domain), the units and the minimum and maximum allowable values ("no limit" is acceptable).

   vi. Other domains are unable to be represented. Include a brief description of what is in these other fields, if applicable.

16. Is this a GIS dataset? If no, skip to item 17.

a. Include a path to where the data can be accessed over the network or send a copy of the ArcInfo export file, an ArcView shapefile, or an ArcCatalog exported metadata file (txt or xml).

   i. Include projection parameters, if necessary.

b. List any source datasets you used. For each source, list:

   i. Source name, originator, and publication date.

   ii. Source time period and scale.

   iii. Source presentation form and media type.

   iv. Contribution of source to your analysis.

Appendix A. Metadata interview form (continued)

c. List the processing steps you used to create your dataset, including the approximate date of processing.

17. Is the dataset available for distribution? If no, you are finished with this interview.

a. Are there legal restrictions on who may use or view the data?

b. Do you have any advice for potential users of the dataset?

c. What are your distribution instructions?

You are done. Send this completed document with the applicable interview responses to your metadata coordinator (Sean Mohren, Klamath Network Data Manager. Sean_Mohren@nps.gov, 541-552-8576)

APPENDIX B. DATA CERTIFICATION FORM

1) Certification date:_____

2) Certified by: _____
Title: _____
Affiliation: _____

3) Project code: _____
Project title: _____

4) Range of dates for certified data: _____

5) Description of data being certified: _____
_____
_____
_____

6) List the parks covered in the certified dataset and provide any park-specific details about this certification.

Parks	Details

7) This certification refers to data in accompanying files. Check all that apply and indicate file names (folder name for images) to the right:

_____ Hardcopy Datasheet(s):_____
_____ PDF Datasheet(s): _____
_____ Database(s): _____
_____ Spreadsheet(s):_____
_____ Spatial data theme(s):_____
_____ GPS file(s): _____
_____ Geodatabase file(s): _____
_____ Photograph(s): _____
_____ Data Logger(s) files: _____
_____ Other (specify): _____
_____ Certified data are already in the master version of a park, KLMN or NPS database. Please indicate the database system(s): _____

Appendix B. Data Certification Form (continued)

8) Is there any sensitive information in the certified data which may put resources at greater risk if released to the public (e.g., spotted owl nest sites, cave locations, rare plant locations)?

_____ No _____ Yes Details:

_____

_____

9) Were all data processing and quality assurance measures outlined in the protocol followed? Yes / No

If No,

Explain_____

_____

10) Who reviewed the products?

_____

11) Results and summary of quality assurance reviews, including details on steps taken to rectify problems encountered during data processing and quality reviews:

_____

_____

_____

_____

APPENDIX C. LOG BOOKS WITH EXAMPLES

Datasheet Log

Name	Position	Date	Page	Reason
Example Joe	Field Crew	12/15/2006	Book 1, Sheet 22	Made a mistake and it was easier to use a new form

Name – The full name of the person reporting the event (e.g., Sean Mohren)
Position – Position of the person reporting the event (e.g., Field Crew)
Date – Date the sheet was found missing (e.g., 8/15/2007)
Page – The page and book number of the missing datasheet (e.g., Book 1, Pg 2)
Reason – Why the page is missing (e.g., Sheet misplaced)

Appendix C. Log Books with Examples (continued)

Equipment Log

Name	Position	Date	Equipment	Event
Example Joe	Data Manager	12/15/2006	Light Censor	Calibration based on instructions in manual

Name – The full name of the person using the equipment (e.g., Sean Mohren)
Position – Position of the person using the equipment (e.g., Field Crew)
Date – Date the change or issues with the equipment occurred (e.g., 8/15/2007)
Equipment – Name of the equipment (include ID # if applicable)
Event – What occurred to the equipment (e.g., Battery died, Calibration, Lost)

Appendix C. Log Books with Examples (continued)

Event Log

Name	Position	Date	Event	Reason
Example Joe	Crew Leader	12/15/2006	Stopped measuring tree DBH	Requested by the Project Manager

Name – The full name of the person reporting the event (e.g., Sean Mohren)
Position – Position of the person reporting the event (e.g., Field Crew)
Date – Date the event occurred (e.g., 8/15/2007)
Event – What happened (e.g., Canopy method change, new employee)
Reason – Why the event occurred (e.g., Old method was found inferior)

Appendix C. Log Books with Examples (continued)

Training Log

Trainer	Trainer Position	Trainee	Trainee Position	Date	Training	Equipment
Example Joe	Data Manager	Sean Mohren	Field Crew	12/15/2006	Photograph Data Entry	Photograph Database

Trainer – The person giving the training (e.g., Sean Mohren)
Trainer Position – Position of the person giving the training (e.g., Data Manager)
Trainee – The person receiving the training (e.g., Joe Smith)
Trainee Position – The position the person receiving the training performs (e.g., Field Crew)
Date – Date or range of dates the training occurred (e.g.,8/15/2007)
Training – The type of training (e.g., Garmin GPS unit usage)
Equipment – If the trainee learned to use specific equipment (e.g., light meter)

APPENDIX D. EXAMPLE DATA DICTIONARY

Dataset: VRKN03E **Klamath Network 2003 Bird Point Counts**
File Type: dbf

Field Name	Field	Required (Y,N)	Type	Length	Decimal	Definition	Enumerated Domain	Range Domain
RECNUM	1	Y	Numeric	20	5	An automatically generated number based on order of entry in original data entry source file		Integer starting at 1, no limit
STATE	2	Y	Character	2		State		
REGION	3	N	Character	8		The first 8 characters of the name of USGS 7.5' quadrangle map on which the first station of the route is found.		
ROUTE	4	Y	Character	8		The 4-letter code for each point count survey route	Each 4-letter code represents itself.	
MONTH	5	Y	Character	2		Month		
DAY	6	Y	Character	2		Day		
YEAR	7	Y	Character	4		Year		
OBS	8	Y	Character	3		Observer Initials		
TEMP	9	Y	Character	2		Temperature	99 = Data not collected	Degrees Celsius, range = -9 to 99

APPENDIX E. REQUIRED PHOTOGRAPH METADATA

Table 1: Required metadata table for all images

*Park Code	*Network Code	Project	*Photo Name	*Date	*Photographer	*Description	Utm East	Utm North	Datum	*Category Folder	*Ext.	*Rights	Collection	Publisher	Resource Type
	KLMN	Landbird							Nad 83 Zone 10		.jpg		KLMN	NPS	Image
	KLMN	Landbird							Nad 83 Zone 10		.jpg		KLMN	NPS	Image
	KLMN	Landbird							Nad 83 Zone 10		.jpg		KLMN	NPS	Image
	KLMN	Landbird							Nad 83 Zone 10		.jpg		KLMN	NPS	Image

1) * Required fields.
2) Populated fields are populated with their default values as shown above.
3) Fields include:

Park Code – CRLA, LABE, LAVO, ORCA, REDW, WHIS
Network Code – KLMN
Project – Name of the project you are working on.
Photo Name – Name of the photograph. Do NOT include the extension.
Date – Date the photograph was taken in the format MM/DD/YYYY.
Description – A DETAILED description of the photograph. Include the name of the site, if applicable.
UTM East and North – The UTM coordinates where the picture was taken, if applicable.
Datum – The datum and zone for the UTM coordinates. The default is Nad83 Zone 10.
Category Folder – The name of the folder where the picture is being stored.
Ext. – The extension – the KLMN requires photographs to be in jpeg format.
Right – Generally, rights are "Public."
Publisher – Owner of the photograph, usually NPS.
Resource Type – What is it? Image, PPT, Graphic – This is usually Image.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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Natural Resource Program Center
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov